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UNDER freezing weather conditions, Lumnite Cement proved its advantages for street work in the construction of two safety islands in Des Moines, Iowa.

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sets in. With ordinary cement, which usually takes from 3 to 4 weeks to reach full strength, cold-weather work has its difficulties; Lumnite Cement is the solution.

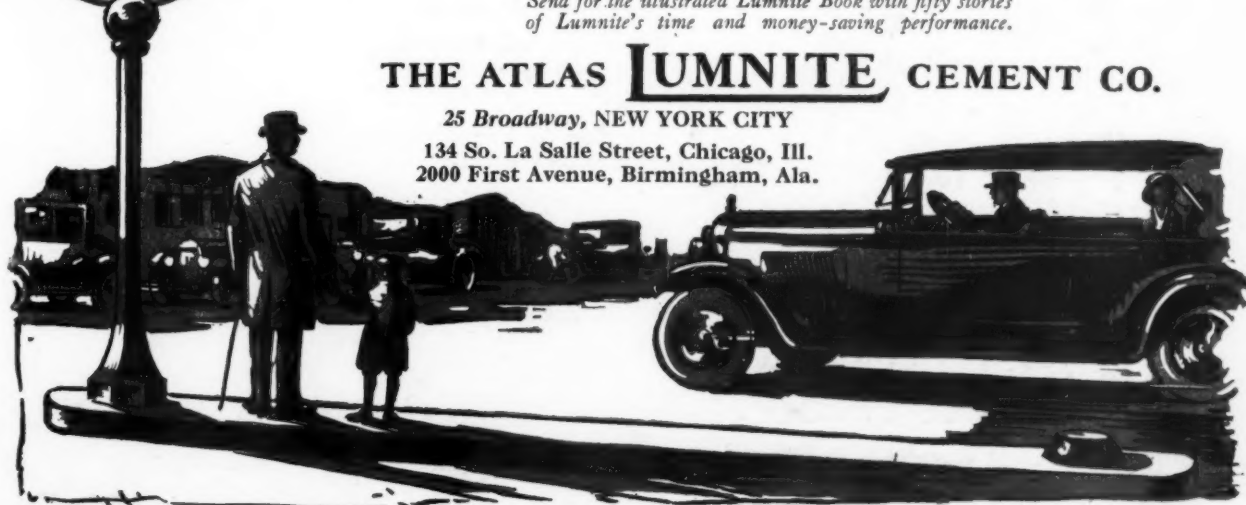
Lumnite has come to the rescue in many cases where lost time meant lost money—where speed was the all-important factor. Lumnite has made it possible for contractors to pour and strip in 24 hours—to complete rush jobs on time and earn large bonuses. Remember, wherever speed is desired in concrete—Lumnite will give 28-day-strength concrete in 24 hours.

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THE ATLAS **LUMNITE** CEMENT CO.

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OCTOBER, 1925

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and indicates a progressive civic administration.



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The quick acceptance of improved methods of maintenance make American cities the cleanest and most sanitary in the world. One hundred and eleven dustlessly Austin swept cities now stand out as the highest examples. This Austin Motor Sweeper sprinkles to lay the dust, brushes the street, including the gutters, and carries the pickup to the dump to be carried away.

*Our large sweeper catalog is very interesting to any
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A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 56

October, 1925

No. 10

Wanaque Dam Construction

Most extensive use of belt conveyors ever made for a construction project, about thirteen thousand feet being used for transporting sand, gravel, cement, concrete and embankment materials. Steel conveyor trestle built into concrete core wall.

In our issue for September, 1924, we described the methods being employed in the construction of the main Wanaque dam, the most notable of which were the use of an elevating grader for stripping off top soil for the impervious part of the embankment—that on the up-stream side of the concrete core wall; and especially the use of belt conveyors for carrying the soil to the embankment, a distance of about 3000 feet, including two river crossings and a crossing under a railroad and a highway.

As described in that and previous articles, the main dam at Wanaque consists of a core wall about 1200 feet long, on the lower side of which is placed an embankment of any material suitable for resisting the pressure of the impounded water but not necessarily water tight, the slopes being 2:1 above the berm and $2\frac{1}{2}$:1 below it. On the up-stream side there is placed against the core wall material selected for its impervious nature, with a slope of 1:1, backed by embankment of non-impervious material with a slope of $2\frac{1}{2}$:1. The up-stream or water slope of the embankment will be surfaced with riprap and broken stone, with 18" paving from approximately the flow line to within 5 feet of the top of the embankment. The flow line of the reservoir is at elevation 300. The core wall is carried five feet higher and the top of the dam to elevation 315.

There are eight other dams and a spillway, all of concrete or with concrete cores. These are

all smaller than the main dam, but several of them are structures of no mean size. Seven of these are constructed to close low points in the south rim of the reservoir where the land dips below elevation 300, while the eighth is to be built across another low point on the east rim about one half mile north of the Wanaque dam, which is on the east rim near the southeast corner of the reservoir. This eighth dam is not included in the present contract.

The seven dams are in two groups, three forming what is known as the Wolf Den dams, which are constructed in almost exactly the same way as the main dam; the other four known as the Green Swamp dams, two of which are of this construction and the other two are concrete dams without embankments.

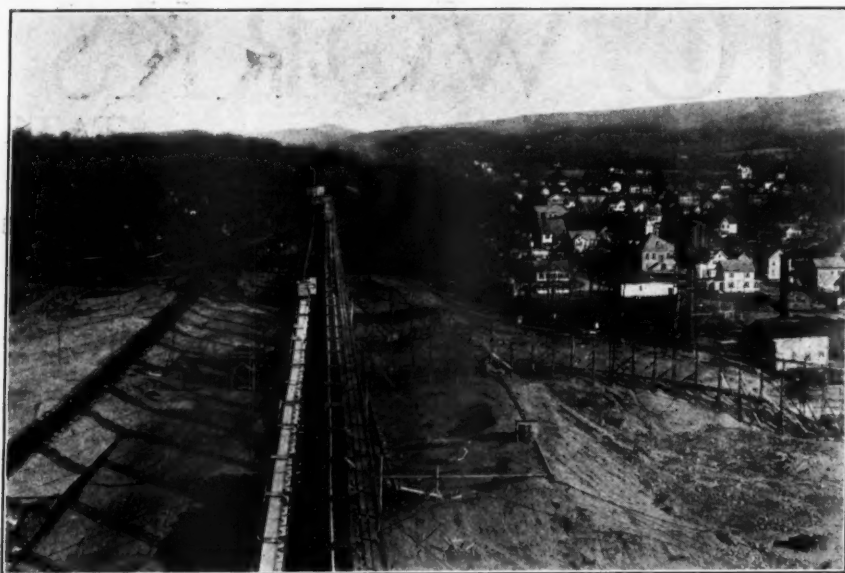
Some idea of the magnitude of the contract is indicated by the figures. There is about 830,000 cubic yards of embankment in the main dam and 120,000 cubic yards in the five other dams. Of concrete there is about 30,000 cubic yards in the main dam and 47,000 in the other core walls and the concrete dams. The excavation exceeds 150,000 cubic yards of which about 40,000 is in rock. These dams extend for one and one-half miles south and west from the main dam.

However, as stated in the previous article, the magnitude of the job is less notable than the equipment used. All of the impervious material is obtained by stripping top soil from 6 to 36 inches deep, using the elevating grader and



UPSTREAM SIDE OF WANAQUE DAM, SHOWING CONCRETE CORE WALL

Trestle carrying belt conveyors shows above core wall. Near the right end is seen a section of the form. The fill against the wall has been placed for about half its height.



LOOKING NORTH ALONG CENTER LINE OF WANAQUE DAM.

Two lines of belt conveyors on the trestle, with a board walk between. Left of the trestle, at the center, is the hopper that received the top soil from the belt for making embankment. Beyond this, on the same side, is a chute delivering non-impervious soil for embankment. (The long, dark line is the shadow of the trestle.)

trucks as described in the article of September, 1924, and also a steam shovel feeding a belt conveyor. All other transporting of material is done by means of belt conveyors except that the gravel for the Green Swamp dams is hauled by motor trucks, and a comparatively small amount of concrete being taken to Green Swamp dam number 4 is being carried by narrow-gauge railway. No animals are allowed inside of the reservoir area. This is probably the most extensive use of belt conveyors ever undertaken for a construction project, nearly $2\frac{1}{2}$ miles of such conveyor being used. Although work was being conducted on four of the dams at the time of our visit, as well as the work of excavating impervious material and gravel, less than 500 men were employed on the entire work.

Another unusual feature is the use of a steel trestle for carrying the belt conveyors over the main dam, the towers of which have been imbedded in the concrete core wall and will serve as reinforcement for the same.

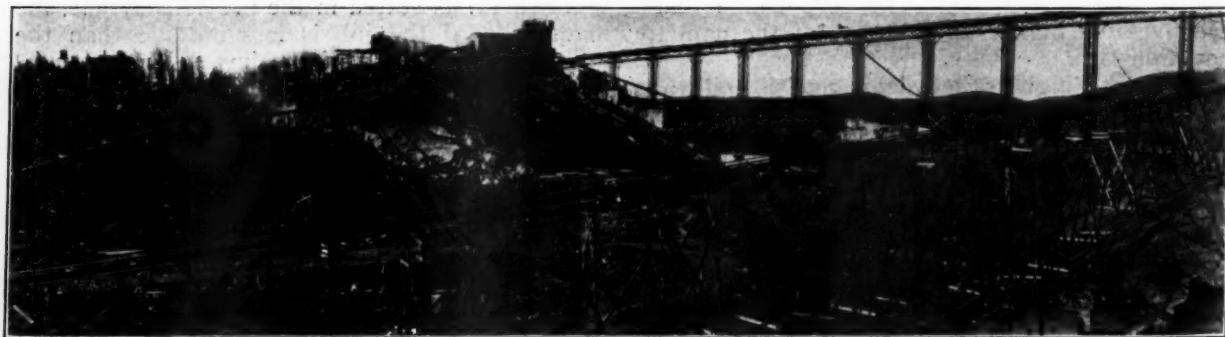
and suspended from a track carried on brackets attached to the trestle. The forms were tied together by bolts made in three pieces, the two outer ends of which were unscrewed from the middle length when the forms were removed, and the bolt holes filled with cement.

A belt conveyor 1450 feet long was installed on the top of this trestle and by means of movable trippers the concrete was spouted wherever desired between the forms. During the Winter this belt was covered with a temporary housing to protect the concrete from the cold, but this was removed when freezing weather ceased. This conveyor is mounted on frames furnished with wheels so that the conveyor can, without being dismantled, be run on to the trestle over the Wolf Den dams, concreting of which was begun a few days ago.

This steel trestle also carries another belt by which embankment material is conveyed to the upper or lower side of the core wall, as may be desired, trippers permitting placing it where-

The concrete for the core wall of the main dam, which has been completed, was mixed in a building located on a hill south of and in line with the core wall and slightly above the flow line. This hill is about 1500 feet north of the nearest point of the Wolf Den dams, which extend in an irregular line for a little over 2000 feet westward, and this concrete mixer is being used for the concrete for these dams also, which will be conveyed to them by means of a belt conveyor; also for the spillway, which is only about 200 feet south of the mixer.

In constructing the core wall of the main dam, the steel trestle was used for supporting the forms, which were made in sections 100 feet long by 16 feet high



PANORAMA OF

Trestle in foreground brings top soil from east side of dam and deposits it on west side. In background is steel trestle that was built into the concrete core wall. At the left end of this, on the hill, is the mixer, and left of this the screens. The conveyor at the upper left hand carries cement to the mixer from the railroad. Near the center of the picture this conveyor crosses the open cut leading to the aqueduct tunnel.

ever needed. The belt for distributing the concrete to the core wall is 20 inches wide and that for distributing earth is 32 inches.

Mean time construction has also been going on at the Green Swamp dams. As these dams are from 4000 to 8000 feet from the main concrete mixer, with very rough, wooded country intervening, it was thought desirable to have a separate mixing plant for this group of dams. This mixer was placed on a knoll which separates dams number 1 and 2. Dam number 3 is quite small. Number 4 is about 1600 feet from the end of number 2, with a hill between, and the concrete for this dam is being carried by bottom-dump concrete buckets, two of which to a car are carried on a narrow-gauge railway around the hill from the end of dam number 2; the buckets being filled by concrete brought by the conveyor used for constructing dam number 2.

In discharging the concrete into the buckets for dam number 4, the belt conveyor discharges first into a hopper and from this by two gates into the buckets; there being two concrete chutes, one for each of the two tracks of a diamond switch on which the concrete cars can be spotted. Water is provided at this point for washing out the buckets as they are returned empty for a fresh load.

In the construction of the Green Swamp dams, the belt conveyor was carried on a light wooden trestle built parallel to, but just outside of, the core wall of number 1 and the body of concrete dam number 2, the tripper discharging the concrete through chutes into position between the forms. Twenty-inch belts were used for this purpose.

For the Green Swamp concrete dams timber



GENERAL VIEW OF GREEN SWAMP DAM NO. 2.

At the right is the dam under construction. Left of it is the belt conveyor on a light timber trestle. Portable canvas coverings are seen, protecting fresh concrete.

forms were used, carried forward by a temporary wooden trestle resting on the previous course of concrete. The expansion joints here were set 30 feet apart.

The difficult foundation for the core wall of the main dam has been described in a previous issue. Green Swamp dam number 4 also presented some difficulty although on a small scale. A spring was found in a deeply worn seam in the middle of the excavation, which, however, was handled without difficulty by a large pulsometer. In order to insure that this and other seams under the dam were made impervious, 2-inch steel grout pipes were set vertically about 10 feet apart, with an occasional special pipe where a visible seam called for it, these being set into holes drilled into the rock and carried up about 12 feet. The concrete was placed around these before grouting was done in order to hold the grout under pressure, and the grout was then forced into the pipes under about ninety pounds pressure.

The gravel and sand used as aggregate for



CONVEYOR TRESTLES.

Leading from the mixer plant to the right, beyond the steel trestle, is the conveyor that brings aggregate material from the gravel pit. Near the center of this picture is a hinged chute for depositing concrete. At its upper end is a tripper for discharging concrete from the belt into the chute. The light construction of the trestles used is seen in the foreground of the other picture.



CORE WALL OF GREEN SWAMP DAM NO. 1.
The trestle has been removed. A section of the form, at about mid-length, has not yet been removed.

the concrete are excavated from a gravel bank by a railroad shovel and discharged into a hopper, from which the excavated material is discharged continuously onto a 30-inch belt. A series of seven belt conveyors, all but the first two set at angles with each other, carry the gravel to the screen located on the hill near the mixer. Of these conveyors, one 1000 feet and another 900 feet long run parallel with the sand bank and are moved over to position alongside the shovel as this eats its way into the bank. These conveyors feed another 470 feet long approximately at right angles to them, which is followed by one 310 feet long, one 430 feet, one 744 feet on about 25% grade which brings the gravel to the top of the hill, and finally by one 205 feet long which discharges into the screens. (These various turnings were made to accommodate the line to the topography.) Thus the entire material is discharged from the bank to the screens without any handling and entirely by belt.

The impervious material is carried by the same belts, being discharged onto them from a hopper fed by tractor-hauled dump wagons and by train fed by steam shovel, and is discharged onto the belt carried by the steel trestle which finally places it in a hopper, from which hopper it is fed into motor trucks which distribute it over the embankment. Here it is spread by a gasoline blade grader and rolled with steam rollers provided with grooved wheels. The gravelly material used for the down-stream embankment is transported by the same belts

and discharged into a chute hopper, from which it is flushed into place by a 4-inch stream of water that is pumped up from the river.

The material screened is taken by two short belts to gravel and sand stock piles respectively. Under these piles is a tunnel in which is a conveyor which delivers either sand or gravel to another 20-inch belt conveyor which delivers the aggregate to the bins above the concrete mixer.

Another conveyor on a 44% grade carries the cement about 800 feet from the railroad siding to the cement house at the mixer.

For the Green Swamp dams, the gravel was brought by truck from the gravel pit and dumped from a ramp into a hopper, from which it was fed onto a belt conveyor, which carried it about 250 feet to a crusher and screens. Cement bags were fed from the same ramp by chute onto the same belt, which carried them to a cement house, from which another short belt carried them to the mixer about 30 feet away. The concrete was distributed by belt conveyors from the mixer to the core walls and dams.



LINE OF BELT CONVEYORS TO CARRY AGGREGATE FROM GRAVEL PIT (AT A) TO SCREENING PLANT.
The small buildings at the angles in the line house the power plants that drive the belts. At the right is the belt that carries the aggregate up the hill to the screens.

The contractor for this work is Clifford F. MacEvoy of Newark, N. J. The work is in immediate charge of Supt. O. H. Kellogg. F. C. Sellnow is senior assistant engineer in charge of this contract for the commission. N. C. Holdredge is assistant chief engineer in charge of all construction, Major Arthur H. Pratt chief engineer, and Morris R. Sherrerd consulting engineer of this and the other work being done by the North Jersey District Water Supply Commission.

Wood Paving Blocks in 1924

According to a recent bulletin of the Forest Service of the United States Department of Agriculture, prepared in cooperation with the American Wood Preservers Association, the total amount of paving blocks treated last year was 1,596,785 square yards. Of this, 561,709 was for outside paving and the remainder, or about two-thirds of the whole, was used for inside flooring.

Of the outside paving, 287,178 square yards of yellow pine and 18,797 of douglas fir were creosoted,

and 238,768 square yards of yellow pine was treated with paving oil, while 16,966 square yards of Douglas fir was treated with other preservatives.

In millions of cubic feet the amount treated in 1924 totaled about four and one-quarter millions, which is the least for any year since 1910, except

1922, when four millions was treated. In 1911 the total reached about ten and one-quarter millions. These totals include inside flooring as well as outside paving, and the decrease since 1910 in amount of wood block used for the latter is, we believe, considerably greater than that indicated by the above

Present Status of Subgrade Studies

Review of the progress of subgrade research, with tentative conclusions therefrom, as reported by the U. S. Bureau of Public Roads.

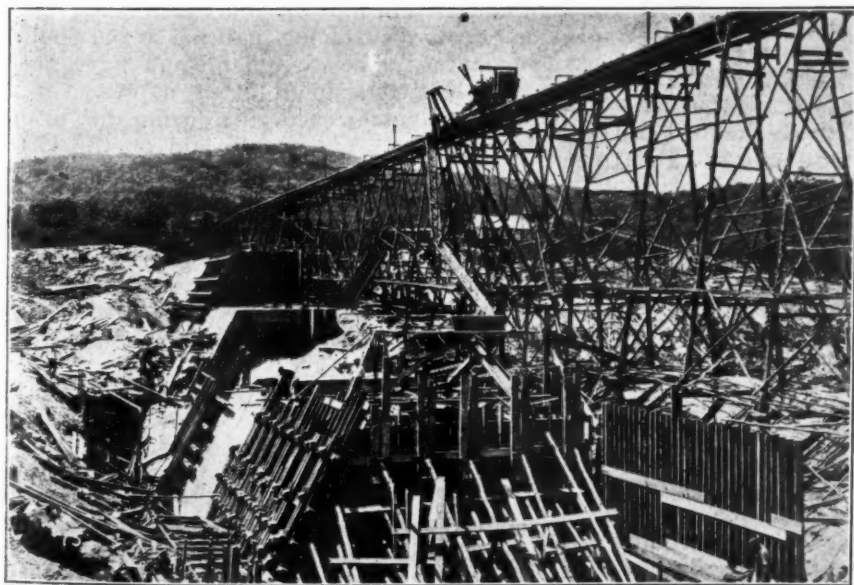
In a comprehensive article of 26 pages long in the September issue of Public Roads, A. C. Rose, associate highway engineer of the Bureau of Public Roads, gives an exposition of existing knowledge of highway subgrades, discussing those results of experience and research which add to the possibility of distinguishing between good and bad subgrade soils; presenting concrete findings which may be practically applied to determine the design of a pavement on a specific kind of subgrade; and indicating the further research that is required to accelerate the progress of our knowledge concerning this fundamental phase of highway design and construction. Special attention is paid to specific data of practical value rather than to theoretical studies. Prominent among the former are those derived from the laboratory and field tests of the Bureau of Public Roads, the Pittsburg (Calif.) test road, and the Bates test road in Illinois.

After presenting the most significant data obtained by each of these and other investigations, analyzing and comparing them, Mr. Rose draws the following conclusions:

Relating to subgrade studies completed or in progress.—1. Generally speaking, all the data obtained in the United States indicate, the character of the clay remaining constant, that good subgrade soils have a low clay content by mechanical analysis and bad subgrade soils are characterized by a high percentage of clay. An illustration of an exception is the "rotten limestone" formation in the Black Waxy Belt of Texas, which, though high in clay is not a bad subgrade material. Pending further investigations, this finding should be accepted with reservations in this country and should not be applied to the soils of foreign countries without a thorough check against local conditions because there are well-known exceptions. An example of the latter are certain soils of the humid, tropical sections of Central and South America. With as much as 90 per cent. of clay by mechanical analysis these soils are porous and not sticky. This is believed to be due to the oxidation of the colloids throughout the centuries in the warm, wet climate.

2. In general, the laboratory tests by the Bureau of Public Roads show that soils with a high percentage of clay have a high moisture equivalent percentage, a high capillary moisture capacity, a high volumetric shrinkage percentage, a low comparative bearing value, a high dye adsorption percentage, and require a long time for slaking.

3. Field methods for identifying good and bad subgrade soils have been devised by the Bureau of Public Roads. These involve the use of Bureau of Soils bulletins to locate the soil types and field tests for determining the moisture equivalent and lineal shrinkage percentages in order to evaluate the character of the subgrade soil.



FILLING FORM WITH CONCRETE, GREEN SWAMP DAM NO. 2.
Trestle for conveyor constructed of poles cut on the ground. Chute carrying concrete from tripper seen in center of picture.

4. The construction methods which may be adopted in bad subgrades, assuming the quality of the materials and the workmanship on the pavement to be uniform, are in general as follows:

- (a) Use upland coarse grained soils for building fills over lowland clay soils.
- (b) Use side ditches of special design.
- (c) Use tile drains. In heavy clays these are generally useless except in uncommon cases such as open seams or pores in the soil, water-bearing strata, or hydrostatic pressure.
- (d) Use a granular subbase such as sand, sand-clay, topsoil, stone, or gravel.
- (e) Thicken the pavement.
- (f) Add steel reinforcement.

5. The study of the California highway system by the Bureau of Public Roads showed that 70 per cent. of the pavement failures occurred on adobe soils. The cracking of the pavements on adobe soils indicated a distortion of the subgrade due to varying moisture content and shrinkage.

6. The laboratory studies of the Bureau of Public Roads indicate that the moisture equivalent percentage of a subgrade soil is a critical percentage with respect to the bearing power of the soil. This does not mean that soils with a moisture content in excess of the moisture equivalent percentage will not support reasonable loads but that beyond the moisture equivalent percentage the bearing power of the soil falls off rapidly.

7. The field experiments of the Bureau of Public Roads in the Pacific Northwest indicate that a lineal shrinkage percentage of 5 per cent. is, for that region, the maximum for a good subgrade soil. The Columbia Pike experiments of the bureau roughly checked this figure. The limit in the latter case was approximately 6 per cent.

8. Defining the term "stability ratio" as the actual moisture content percentage of the soil divided by its moisture equivalent percentage, the field investigations of the Bureau of Public Roads in the Pacific Northwest indicate that the bearing power of a soil is relatively low when the stability ratio is greater than unity. This does not apply to frozen soils. The bearing power of the soil by laboratory tests is relatively low also when the "moisture index" is greater than unity.

9. Clay soils, as compared with sands, show a relatively large heave when frozen according to field tests by Stephen Taber, State geologist of South Carolina.

10. Bureau of Public Roads laboratory tests show a greater percentage of water freezable in sands than in clays. This does not mean that the amount of the heave in sands due to freezing will be greater than in clays. On the contrary, it would seem that the greater heaving would occur in clay with capillary water present because of the greater total amount of water frozen.

11. In climates where freezing occurs, field

observations indicate that for concrete pavement slabs of 60 feet or less in length:

- (a) Cracks are infrequent in pavement laid on well-drained sand or porous subgrades.
- (b) The more compact the subgrade soil, the more frequently cracks occur.

12. The permeability of soils or the porosity seems to increase with the size of the soil grains, the character of the grains remaining constant.

13. The best subgrades are found in fills and the worst in cuts.

14. The selection and redistribution of subgrade soils to secure a stable roadbed is a possible method of construction. The use of a granular subbase over the undisturbed subgrade soil is the more general practice.

15. A sand subbase prevents clay subgrade material from working up into the voids of a macadam road.

16. The Pittsburg and Bates Road soil findings indicate that the character of a subgrade soil may be improved by physical or mechanical processes.

17. The investigations of the Bureau of Public Roads indicate that the bearing value of a soil, for a given penetration of the bearing area, depends on the magnitude of the area. When small bearing areas are used, the intensity of pressure required to produce a penetration of 0.1 inch far exceeds that for large-sized blocks.

18. Sufficient work has not been done up to this time to determine the practicability or impracticability of using admixtures such as Portland cement or hydrated lime to improve the quality of subgrade soils.

19. Granular subbases seem to be more beneficial on bad subgrades than admixtures of Portland cement or hydrated lime.

20. Sand is as effective as Portland cement or hydrated lime when used as an adulterant to reduce the shrinkage of a clay soil.

21. Semigravel, topsoil, and sand-clay roads provide effective surfacing material in the Southeastern States. They could be and have been used elsewhere but under other names.

22. The hair cracks occurring during the curing period of concrete pavements laid on the loess soil of western Iowa were eliminated practically by a layer of tar paper on the subgrade.

23. Investigations made by the Bureau of Public Roads indicate that it may be possible to control the maximum moisture content of a subgrade to approximately the moisture equivalent percentage. Further studies are needed to confirm or disprove this.

24. It is not possible to remove capillary water from subgrades by drainage. Free water only may be removed by practical methods.

Relating to future subgrade soil studies—Subgrade studies* which seem to be immediately necessary to accelerate the progress of subgrade soil investigations should involve probably not

*Digest of problems in the structural design of highways suggested by contact men in the various State highway departments, Proceedings of the Fourth Annual Meeting of the Highway Research Board, Division of Engineering and Industrial Research, National Research Council, 1925, p. 66.

only the internal characteristics of different subgrade soils under varying physical and chemical conditions, but also the limiting external forces which may be applied to the subgrade soils under given conditions.

The specific studies which seem to be required immediately are:

1. A classification of soils by series and type names to conform as nearly as possible with the nomenclature and grading used by the United States Bureau of Soils in its soil survey bulletins.
2. The development of simple and decisive laboratory and field tests for subgrade soils.
3. The determination of the distribution of pressure to subgrades of various types through pavements and subbases of varying thicknesses and kind.
4. The determination of the maximum pressure per unit of area permissible, with various types and thicknesses of pavements and subbases, for different soil types with varying percentages of sand, silt, and clay.
5. The determination of the maximum moisture content of well-drained soils, by types and regions, throughout the year, and the maximum moisture content below which it is possible to control the water content of soils by types and regions.
6. The determination of the characteristics of soils, by types and regions, which make one more plastic than another and subject to a greater volume change with variations in moisture content, etc. If found that the active part of a soil is rendered inert over long periods of time by natural physical and chemical phenomena, investigations should follow to determine if similar results may be accomplished by accelerated artificial processes.
7. The determination of the maximum allowable shrinkage limits of soils wetted with comparable amounts of water (such as the moisture equivalent or capillary percentages) by soil types and regions. This would involve condition studies of existing pavements.
8. The determination of the mechanical analysis, moisture equivalent and other test limits of those soils with varying degrees of permeability such that tile drains are either unnecessary, effectual, or worthless.
9. The discovery of the stages which accompany the phenomena of freezing of soils under existing pavements:
 - (a) Under continuous freezing conditions.
 - (b) Under conditions of alternate freezing and thawing.

South American Representation on Highway Research Board

The Highway Research Board of the National Research Council is extending an invitation to the Latin-American universities to designate honorary representatives to serve as liaison officers between the board and the universities. The invitations will be presented personally by Dean A. N. John-

son, chairman of the Highway Research Board, who is now attending the Pan-American Road Congress in Buenos Aires.

It is believed that both the universities and the board would benefit by the exchange of information thus facilitated.

Limit of Traffic on Twenty-Foot Road

Eleven hundred cars in each direction is about the limit of traffic that can use a 20-foot road under the most favorable conditions, in the opinion of Van Alen Harris. In discussing a paper by A. N. Johnson before the American Society of Civil Engineers entitled "Elements Governing the Development of Highway Traffic," Mr. Harris said:

"The viaducts across Biscayne Bay between Miami and Miami Beach, Fla., are illustrations of traffic saturation. The distance across the Bay is three miles, of which the larger part is a causeway with plenty of room for a very dense traffic. At each end of the causeway is a viaduct 2,000 ft. long and 20 ft. wide between curbs, allowing only one line of traffic in each direction. The speed limit is 25 miles per hour, with no passing of cars going in the same direction on the viaducts.

"Miami Beach, with a building program of \$4,000,000 per year, is a high-class residential section, and also the ocean bathing resort of Miami. Practically all labor working at Miami Beach comes from Miami across these viaducts and causeway. This flow of workmen returns to Miami between 4.00 and 6.00 p. m., which is the same time that the bathers return to Miami, with the consequent peak traffic between these hours.

"In the summer of 1924, that is, out of the tourist season, 8,400 automobiles and trucks were counted crossing in 1 day, and between 1,200 and 1,300 in 1 hour, at the peak of the traffic, of which about 85% was going in one direction. No more could have passed, as there was a steady stream of cars which were urged to go as fast as possible, but, although the speed limit is 25 miles per hour, the average speed during the congestion was about 18 miles per hour. It may be assumed, therefore, that about 1,100 cars in each direction is the limit of a 20-ft. road under the most favorable conditions."

Pavement Cracks on Loess Soil

Loess soil is a very finely divided material which is eroded rapidly by rain water, but will stand on a slope that is almost vertical. It is said by geologists to have been deposited by wind over glacial drift. It extends from the Missouri river for a distance of fifty miles or more. The first concrete pavement laid on this soil by the Iowa State Highway Commission developed fine cracks that extended through the pavement and were found occurring generally where the loess soil was dry, or only slightly moist, and generally where the pavement had been laid downhill.

In later work this cracking was eliminated to some extent by thoroughly wetting the subgrade immediately prior to pouring the con-

crete. Where the pavement was laid on a subgrade which had been thoroughly wet by rain, no cracks appeared.

Only three remedies suggested themselves: either the concrete must always be laid uphill, which would seem to be impracticable; or the subgrade would have to be saturated; or possibly an impervious layer might be placed between the subgrade and the concrete.

The Highway Commission prevented the cracking to some extent by thoroughly wetting the subgrade just before pouring the concrete. A much more effective method, however, was found to be the placing of a layer of tar paper on the subgrade before laying the pavement. This tar paper treatment has been found to be especially successful and is now the standard practice for concrete pavements laid on this type of Iowa soil.

The use of tar paper is not suggested as a cure for all hair cracking. It apparently does not decrease the amount of transverse and longitudinal cracking which develops after the pavement has been built and opened for traffic.

When the second pavement on this type of soil was contracted, the contractor was given the option of using tar paper, or thoroughly wetting the subgrade for the length of one day's run ahead of the mixer. He chose the latter, but found that it required a great deal of water, and when it was wet enough, it was too muddy for the trucks to operate properly. On later contracts the tar paper has been required and the hair cracks have been practically eliminated. On fourteen miles completed in 1924 only two small patches of cracks have been noted and it is known definitely that in one of these cases the tar paper was omitted.

Concrete Highway Construction in Alabama

Methods and appliances used in constructing a modern road in Jefferson County. More than half of old road relocated to meet grade and curvature requirements. Slag concrete used for paving. Water for concrete piped nearly two miles.

By P. A. Davis

In the construction of seven miles of concrete highway in Jefferson County, Alabama, heavy grading and much new location have been necessary. The entire length of the road under construction is along the southeastern slope of Shades mountain, from the summit to the foot at the Cahaba river. This section of Alabama, noted for its iron and coal production, is very rugged. An idea of the character of the work may be gained from the fact that on the seven miles under construction there are thirty fills of 10 feet or more totalling over 10,000 feet of length.

The road is being built jointly by the State of Alabama and Jefferson County, and extends from the end of present county pavement to the existing state highway at the Cahaba river. It is one of the final links in the Birmingham-Montgomery highway. This highway, connecting Birmingham, the state's largest city, with Montgomery, the state capitol, 106 miles south, is of the most modern high-speed construction, with curves of long radius and with no grades exceeding 6 per cent.

As a through highway, it will be called upon to carry a very heavy traffic at all times. Florida travel in the spring and fall is always very heavy; three large passenger busses run on regular schedule between Birmingham to Montgomery each bus making 3 trips daily; and

when the road is finished throughout its entire length, there will doubtless be a tremendous trucking load as well.

Concrete has been selected for the pavement, mainly because of the lower cost. The paved portion of the road will be 18 feet wide, with shoulders of natural soil, 2 feet wide, on each side.

The old road is followed for something less than 3 miles, while new location was necessary in order to meet the requirements of grade and curvature for slightly over four miles. Preliminary estimates indicated that there would be approximately 150,000 yards of earth grading and 50,000 yards of rock excavation; but as the work has progressed, additional rock has been encountered, and it appears likely that nearly half of the total will be rock work. The contract price for earth excavation is 30 cents per yard, and for rock \$1 per yard.

For shallow grading on short hauls, and for removing surface material, the contractor used Western wheeled scrapers. Under average conditions the scrapers, of which there were 16 on the job, moved about 35 yards per day per scraper. These proved very efficient and satisfactory.

The work of grading was simplified by the exceedingly dry summer. There have been no rains since spring and early summer, and as

a result there have been no delays or other trouble such as are inevitable in earth handling in clay soil in wet weather. This has also simplified the problem of detours, always a matter of much difficulty and especially so in wet weather.

Heavy grading has been done mostly by a Northwest gasoline driven shovel, though a steam shovel also was used for the grading until recently. These were used on all the cuts too deep for economical scraper work. The Northwest shovel is equipped with a $\frac{3}{4}$ yard bucket and has handled as much as 500 yards per day. Excavated material is loaded into $1\frac{1}{2}$ -yard Watson wagons, twelve of which are used on the job. The limit of haul is about 1300 feet.

As already stated, rock excavation has been heavy. The rock is of various kinds, including limestone, shale, and a tough sandstone. Denver rock drills have been used for drilling, and holes up to 20 feet in depth have been necessary in the deeper cuts. The drills are operated by com-



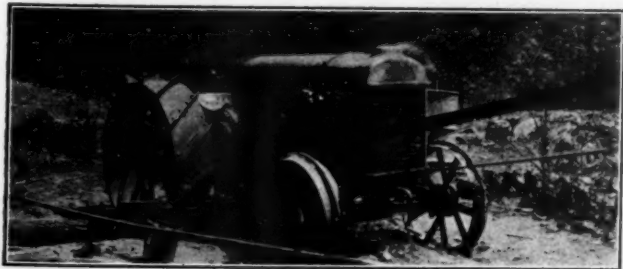
NORTHWEST GASOLINE SHOVEL OPERATING IN ROCK CUT, LOADING WATSON WAGONS.

pressed air produced by Ingersoll-Rand portable air compressors driven by Fordson tractors. For blasting, 60 per cent Atlas dynamite has been used mainly, but also some black powder.

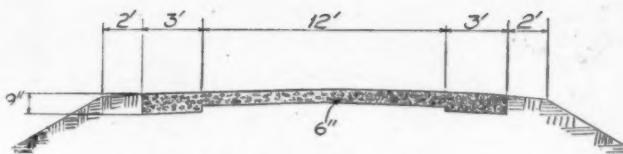
The largest fill is 57 feet deep and 300 feet long, and contains 18,000 cubic yards of material. There are 30 fills of more than 10 feet depth in the 7 miles of construction.

Concrete box culverts are used throughout. These are designed along usual lines as to capacity and strength.

Paving is of concrete, mixed 1:2:3. The paved portion of the road is 18 feet in width, 9 inches thick at the edges and for a distance of 3 feet from each edge, and 6 inches thick throughout



FORDSON TRACTOR OPERATING INGERSOLL-RAND AIR COMPRESSOR FOR DRILLING.



CROSS-SECTION OF JEFFERSON CO. CONCRETE ROAD.

the center 12 feet. The crown is 2 inches. No reinforcement is used. Expansion joints of asphalt one inch thick are placed at 40-foot intervals. Shoulders two feet wide are to be constructed along the edges of the finished pavement.

No paving will be placed this year on fills more than 10 feet in depth. It is, of course, very unsatisfactory to pave unsettled fills, especially when there have been no heavy rains to soak the earth thoroughly. On the seven miles under construction, there are two miles of fills over 10 feet deep. These two miles will be paved next summer after the winter rains and a year of traffic have compacted the fills beyond danger of further settlement.

Slag, sand, and cement for the road have been stored in stock piles at various strategic points along the road. For the southern half of the road, material was shipped to Acton, where railroad facilities are available. For the remainder of the road, a part of the slag was shipped to Oxmoor and the remainder furnished by a small crushing plant located at that place. Oxmoor is about 4 miles from the part of the road served, and the slag had to be hauled by motor trucks this distance. This includes the ascent of the north slope of Shades mountain, which is a very severe climb.

For hauling the aggregate from Oxmoor, two five-ton Mack trucks were used. These made four round trips daily, or 32 miles, carrying 5 tons of material each trip, or 20 tons per day, at an average operating cost of \$30 per day.

Material, as stated, was dumped in stock piles. From these it is loaded into Ford trucks to be hauled to the mixer. These trucks, of which there are nine on the job, carry material for one charge of the mixer—5 sacks of cement, $11\frac{1}{2}$ cubic feet of sand, and 18 cubic feet of slag. The truck first goes to the sand pile, where the sand is loaded; thence to the cement platform, where 5 sacks of cement are emptied into the body; and finally to the slag pile, where 18 cubic feet of slag are added. This is carried to the mixer and dumped directly into the scoop of the mixer. On average runs of about one mile each truck makes an average of 20 trips daily. To avoid cutting the subgrade, and to facilitate handling of the trucks in soft ground, large-sized pneumatic tires are used.

Barber-Greene traveling loaders are used for raising the sand and slag from the stock-piles, measuring the charge, and dumping into the trucks.

Slag is used instead of broken stone for the coarse aggregate. The size varies from $1\frac{1}{2}$ -inch down to rather fine material. Both slag and

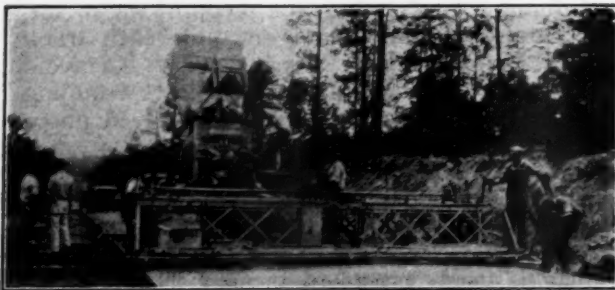


LOADING MATERIAL FOR ONE BATCH INTO FORD TRUCK.

Barber-Greene loader raises and measures 11½ cubic feet of sand; 5 sacks of cement are then added; finally another loader delivers 18 cubic feet of slag.

sand are furnished by the Birmingham Slag Co. Phoenix portland cement is used, which is also a Birmingham product.

A Multi-Foote paving mixer No. 21, having a capacity of about ¾ yard of concrete, is used to mix the concrete for the pavement. A total of only ten men are employed at the mixer, of which 3 operate the finisher, 4 spread and level off the fresh concrete, and 3 assist in the charging and operation of the mixer. The maximum pavement laid in any one day is 400 feet, while the average day's work is about 320 feet. Good progress has been made, and it is expected that the work will be finished this fall.



CONSTRUCTING PAVEMENT, USING MULTI-FOOTE PAVER AND HELTZEL FINISHER.

Blaw-Knox forms are used for constructing the pavement, and a Heltzel finishing machine for smoothing and finishing the wet concrete. The surface of the concrete, after finishing, is protected by a layer of canvas. This is allowed to remain for 12 hours, after which it is replaced with a layer of earth. This remains for 18 days, being kept thoroughly wetted during this time. It is then removed, and the concrete allowed to cure for 3 days more, after which the road is thrown open to traffic.

The procuring of water necessary for the work of construction has been rather difficult at times. Owing to the exceedingly dry weather, all the smaller streams and branches have dried up. For a time water was hauled 4 miles from the Cahaba river, but lately it has been available from Patton's creek. This is forced through 8,000 feet of 2½ and 2-inch pipe by means of an electric driven Hercules pumping unit. Connections are inserted at 200-foot intervals along the pipe line for wetting down the earth cover of the concrete for supplying the equipment with water.

Because of the excellent system of roads throughout Jefferson county, the detour problems has not been a serious one. Good minor roads have been available for detours in most cases, and these have been kept well marked. A few short temporary detours have been necessary. The very dry summer aided in keeping these in good condition and there have been few complaints.

Practically all the common labor on the job is colored. The men work 10 hours per day and are paid 30 cents per hour. Most of the men stay at the contractor's camp which is maintained at a convenient location.

J. J. McArthur is the general contractor for the work. J. W. Walker is superintendent in charge of the grading work, and O. A. Bowers is in charge of paving, with H. L. Wigley as general foreman.

Auto Surveying

An interesting incident is interestingly described in a recent issue of "California Highways," the monthly bulletin of the California Highway Commission, by Fred J. Grumm, engineer of surveys and plans.

It seems F. G. Somner, division engineer of Division IX, was expected to present to the department head certain general facts and figures concerning two alternative routes between Ricardo and Little Lake. One had been surveyed but the other had not been as yet. As Mr. Grumm tells it:

Somner was up against it. He had no survey of the valley route; the department head from headquarters was expected on the evening train; it was noon and he had no survey party. From Ricardo to Little Lake is 35 miles, more or less.

Enter Resourcefulness and Expediency, Children of Necessity. He had an automobile with a good speedometer, one of those dollar compasses, a pencil, paper and a book of tables. He organized a one-man survey party.

It was complete from locator to axeman; in fact, it even included a division engineer.

The result was a *Triumph over Difficulties*. He made his survey of 20 odd courses tying in just north of Ricardo. Down at Mojave, using the landlady's dining room table, the survey was plotted on the map of the precise location survey. And it checked at the proper point within 200 feet. Two hundred feet in 35 miles! Have you done any better with your stadia surveys? Oh yes, once—maybe! When the department head arrived there was something to offer as a basis for comparison.

In the words of Chester Gump's Chinese servant: It is written that the Resourceful Person will Triumph over Difficulties.

Columbus Sewage Disposal

Chemical and bacterial results of the plant in 1924, sludge disposal, and cost of operation. Sewage pumping.

In the 17th annual report of the Division of Sewage Disposal of Columbus, Ohio, C. D. McGuire, chemist in charge, reporting to C. B. Hoover, superintendent of the Division, stated that the Imhoff tanks during the year had removed from the crude sewage 96 per cent by volume of the settleable material and 60.6 per cent of the total suspended solids; the detention period having averaged 4.6 hours. Consumption of dissolved oxygen was reduced 38.5 per cent by the tanks and the stability value of the tank effluent was 2.7 above that of the crude sewage.

The sprinkling filters retained 23 per cent of the suspended solids from the tank effluent applied and decreased the consumption of dissolved oxygen 77 per cent. The filters increased the stability 31.6 and produced 3.4 parts per million of nitrogen as nitrates and nitrites in the effluent.

The whole system removed 69.7 per cent of the total suspended solids from the crude sewage; reduced the dissolved oxygen consumption 85.7 per cent and increased the stability value 34.3.

The plant was operated 185 days and treated 4,571 million gallons. The mean dose per acre was 2.64 million gallons daily. The filters were in service 58 per cent of the time.

During the past two years the major portion of the sludge removed from the tanks has been flushed to a lagoon. This made it possible to draw sludge at any time and thus permitted the operator to prevent any foaming of gas vents in the Imhoff tanks. The amount of wet sludge produced at Columbus is about 7.6 cubic yards per million gallons, or roughly, 2.9 cubic yards of dry sludge.

Among the results of the treatment during 1924 the following averages appeared: the suspended solids in the crude sewage totaled 208 parts per million, of which 102 parts or 49 per cent were settleable solids. The total suspended solids were reduced to 82 parts in the tank effluent and 63 parts in the sprinkling filter effluent. Figures for dissolved oxygen consumed in 24 hours at 37 degrees C. were 364 for the crude sewage, 224 for the tank effluent and 52 for the sprinkling filter effluent. The methy-

lene blue stability values were 4.7 for the crude sewage, 7.4 for the tank effluent and 39 for the sprinkling filter effluent.

The total cost of disposal, including bond charges as well as operating costs, was 57.4 cents per capita, of which 18.9 cents was operating costs. Of the operating cost, 13.3 cents was for pumping, 4.2 for treatment, 0.9 for administration, and 0.5 for night soil treatment.

Three sewage pumping stations were operated—the Nelson Road, the East Side and the main station. The East side station pumps the dry flow sewage and small amounts of storm water over the natural divide between Alum creek and Scioto and Olentangy rivers. It contains one four million gallon Weinman direct connected, motor driven centrifugal pump, and one six million gallon Morris, horizontal, direct connected, motor driven centrifugal pump; also a 20-inch by 7½-inch Venturi tube with recorder and register. The main sewage pumping station pumps the flow from any of the four sewers discharging into the suction wells to either the sewage treatment works or the Scioto river. It contains five horizontal, direct connected, motor driven centrifugal pumps with a rated capacity of fifty-one million gallons daily; also a 48-inch by 20-inch Venturi tube. During the year 1924, all the sanitary sewage flowing to the main station was pumped to the treatment works; the total amount pumped being 4,571 million gallons. The total operating cost was \$25,067 or \$5.48 per million gallons. Cost for power was 27 per cent less than in 1923 although the pumpage was only 15 per cent less; the reduction being due to the installation of new open type impellers in two DeLaval pumps.

Among the general statements made in the report is one that at least one square foot of sludge bed area per capita is necessary to handle the sludge produced in the two-story tanks, although the Columbus plant has only 0.4 square foot per capita. Although the present flow of sewage reaches a rate of 37½ million gallons, the present area of the sprinkling filters was designed for and will handle only twenty million gallons.

Framingham Sewage Treatment Plant

This article is concerned with the construction and operation of two new Imhoff tanks, sludge beds and sand filter beds to supplement and improve upon an existing old sewage disposal plant consisting of 12 acres utilized for "intermittent filtration," and 57 acres devoted to "broad irrigation." Provisions for discharging Imhoff-tank effluent to the old area have been made by a diversion chamber cut into the connection to the new sand filters.

The two Imhoff tanks are of the rectangular, horizontal, reversible-flow type, with each unit designed to treat the sewage of 5,000 people. Each settling compartment has a volume of 6167 cubic feet, providing for a detention period of two hours and twelve minutes when the flow is 500,000 gallons per day. Each unit of the digestion chamber has a volume of 10,063 cubic feet or 2 cubic feet per capita for 5,000 people. Gas vents are provided

along each side and through the center of each tank, the total gas area being 21% of the superficial area of the tanks. Each digestion chamber has two inverted pyramidal bottoms with slopes of one vertical to two horizontal and to insure movement of the sludge in emptying the chamber, two rings of 2" cast iron pipe with $\frac{1}{8}$ " drilled holes, spaced 18" on centers, connected with a water supply obtained from a well excavated in one of the adjacent filter beds are provided.

The sludge beds have a total area of 10,000 sq. ft. or one sq. ft. per capita for 10,000 people. They are constructed of 10" of coarse stone covered by 1" of fine stone and 1" of sand, and are underdrained by 4" pipes laid 6' apart, which connect with the main underdrain system of the new filters.

The filters comprise a total sand area of approximately 8 acres divided into 16 beds. In the center, there is placed a concrete dosing tank holding 1,545 gallons per foot of height and having a maximum depth of liquid of 4.6 feet. It is provided with a dosing apparatus including a Miller siphon. The object of this tank is to change the continuous flow from the Imhoff tanks into an intermittent discharge at a rate high enough to insure good distribution over the sand beds. The filters are composed of sand underdrained at an average depth of 4 feet by pipes laid with open joints and surrounded by screened gravel.

The total cost of the Imhoff tanks, sludge beds, sand filters and dosing tank, weir chamber, force main connection, connection to old disposal plant, etc. was \$116,585.

Abstract, by the Bureau of Public Health Service, of a paper by F. W. Haley in the "Journal" of the Boston Society of Civil Engineers for June, 1925.

Disposing of Phenol Wastes

Methods employed and proposed in this country and Europe. Coke quenching the cheapest method available. Washing with benzol may be developed practically.

A brief review of the subject of stream pollution by wastes from by-product coke ovens, by R. D. Leitch, associate chemical engineer, U. S. Bureau of Mines, is published in the September 25 issue of "Public Health Reports." In this Mr. Leitch refers to the numerous cases of disagreeable tastes produced in water supplies by phenol, especially when intensified by chlorination of the water; also to the fact that small amounts of such wastes in streams kill fish. At a conference of State health officers and manufacturers held in 1924 it was stated that on the Ohio river watershed 19 plants producing phenol wastes were polluting 25 water supplies, and that 31 towns and cities in the district had already reported trouble from these

wastes and approximately 25 more were potentially liable to have trouble from the same sources.

"Figures for the volumes of phenol wastes are not easily determined. In 1923, more than 55,000,000 net tons of coke were produced; and of this amount about 37,000,000 tons were from by-product ovens. Some of these plants dispose of the wastes by quenching the coke; but if we assume 250 gallons per ton, which seems a fair estimate, there are more than 38,000,000 tons of still wastes to be disposed of annually. It may be estimated that only 60 to 75 per cent of this total is being run into streams, as some of the largest coke producers are utilizing the wastes for coke quenching. On January 1, 1924, there were 709 ovens under construction, of which 541 were as additions to existing plants and the remainder divided among seven small new plants. These additions will increase coke production in 1924 by about 4,500,000 tons, making the total for 1924 approximately 60,000,000 tons, and the total from by-product ovens about 40,000,000 tons.

METHODS OF DISPOSAL

"There are several methods of disposing of phenol wastes at present being utilized, and while not by any means ideal they offer partial solutions of the problem.

"The use of these wastes for coke quenching is the most common method of disposal, and when applicable, is the most certain method, i. e., evaporation.

"Recirculation has also been found adequate in various gas works as well as systems of skimmers, settling basins, and filters.

"The Milwaukee Sewerage Commission has found that phenol wastes may be easily disposed of, at least in amounts not exceeding 2 per cent by volume of the total sewage, by admitting these wastes to municipal sewage, when the activated sludge method of disposal is in operation. Comparatively little work has been done toward determining the maximum percentage that can be taken care of in this manner; but it is thought that a volume of 10 per cent or even more may be satisfactorily handled.

"The Bradford Road Gas Works, Manchester, England, as early as 1908-1914 successfully disposed of these wastes, for six years, at least, by using the bacterial filter. An improved design has had apparent success on a laboratory scale, as it ran satisfactorily and continuously for a year and was functioning as well at the end of that time as at the beginning. The method in principle is the same as that in the activated sludge sewage disposal plants, i. e., it consists in the oxidizing action of certain bacteria on organic substances. A filter of peat or other humus material is mixed with coke to prevent packing, activated sludge or manure is added to plant the bacteria, and a mixture of clean water and still wastes, in the proportion of 85 per cent or 90 per cent water and the remainder waste, is allowed to trickle slowly through the filter bed. The phenol bodies are oxidized and 10 to

15 per cent of the clear effluent is discarded and a like amount of fresh still waste is added for make-up to be recirculated. The operation is continuous and is said to be very satisfactory.

"A German patent claims, in addition to successful operation, a recovery of the contained phenols in salable form. This method consists in passing the still waste through acid resins obtained in the purification of benzol, agitating the resulting liquor with benzol in a washer containing two-thirds benzol and one-third wastes, by which the phenol dissolves in benzol. The phenol-free waste is then drawn off, caustic soda solution is pumped into the washer, and the mixture again agitated. The phenol soda is formed and drawn off, while the benzol may be used over again. The phenol-soda solution is used in chemical plants in the manufacture of tar paints for rust proofing.

"Other processes have been patented based on reduction by carbon monoxide or sulphur dioxide, with and without the use of catalyzers, and ozonization, but no evidence is apparent indicating their commercial use. So far as is known the three methods previously outlined are the most feasible, exclusive of coke quenching.

"Since there are no known installations of the types mentioned in commercial operation in this country, we can only make estimates of the costs of the different methods.

"When the amount does not exceed 2 per cent

of the total and the activated sludge method is used, addition to municipal sewage is, of course, the cheapest method and means only the cost of piping to the nearest sewer.

"The bacterial filter is estimated to cost about \$15,000 for a capacity of 20,000 gallons of still wastes per day; but doubling the capacity will not double this cost by any means.

"In spite of the fact that the cost of disposal by coke-quenching is estimated by the largest by-product coke company in the world to be \$60,000 per year for repairs and replacement of equipment destroyed by corrosive gases resulting from this method of disposal, it is still the cheapest method now available per ton of coke produced. Its use may be limited, however, to those plants manufacturing coke for industrial rather than domestic use. In the latter case the appearance of the coke and the odors from it hinder its sale to a very great extent.

"Assuming that the patented methods of ozonization, reduction, etc., are successful, it is likely that their cost would exceed that of any of the others.

"There are two general methods involving washing of the liquors with benzol, previously mentioned, and possibly others of the same classification that appear very promising, but no data are at present available to warrant any definite statement as to cost or efficiency in operation."

Hydrogen Ion Concentration and pH†

What it is and its application in water purification practice and sewage disposal described in easily understandable language.

By Linn H. Enslow *

Since hydrogen (H) is the active element common to all acids, the degree of acidity of a solution is best determined by measuring the concentration of hydrogen ions present.

For the sake of simplicity the hydrogen ion concentration is generally expressed by the pH value of a solution. This symbol was coined to express the relative number of hydrogen ions present in terms easily written and remembered. At pH 7 there are present an equal number of alkali (hydroxyl) ions and acid (hydrogen) ions. These opposed ions balance one another and a neutral solution results. At pH 6 there are ten times as many hydrogen ions as are present at pH 7; likewise at pH 5 there are ten times as many as at pH 6 and 100 times as many as at pH 7. As the pH value drops toward zero, the hydrogen ion (H) concentration and therefore the degree of acidity increases. Each unit decrease of pH value represents a tenfold increase of hydrogen ions. The same reasoning applies to the decreasing acidity and therefore increasing alkalinity. Beginning at pH 7 the alkalinity increases tenfold for each unit increase in pH value. At pH

14 the solution is very alkaline, the hydrogen ions having been gradually forced out by the hydroxyl (OH) or alkaline ions.

It is quite important to realize that so far as acidic power is concerned, a change from pH 5 to pH 7 indicates a suppression of active hydrogen present to such an extent that it is but one one-hundredth (1/100) the strength of the solution of a pH value only two units less.

As an illustration of what the degree of ionization of the hydrogen of acids means in comparison to the strength expressed in percent of total acid hydrogen present, one may compare N/50 sulphuric and N/50 acetic acids. Both contain an equal weight of the total acid hydrogen. The power of the sulphuric acid to dissolve metals, however, is approximately 70 times that of the acetic acid solution. For every ion of hydrogen present in the acetic acid there are approximately 70 ions of hydrogen in the sulphuric acid. Its strength from the hydrogen ion concentration viewpoint is therefore 70 times that of acetic acid.

To extend the illustration, one can readily see why a solution containing 5 per cent. sulphuric acid tastes so strongly acid while the ordinary house-

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†Paper before meeting of Chlorine Institute.

hold vinegar containing 5 per cent. acetic acid is non-injurious in comparison, and does not put an "edge" on the teeth as does the 5 per cent. sulphuric acid.

Consider two grades of coal which have identical percentages of combustible matter and ash content. These are most likely different in B.T.U. or heat values. The weight of combustible matter in a given weight of the coal is analogous to the weight of the total or titratable acid in a given volume of a solution. The B.T.U. or energy value of the coal is analogous to the hydrogen ion concentration and therefore the energy value of the solution. In the case of the coal the energy value is determined by its B.T.U. characteristic and not by the total combustible matter present. Similarly, the strength of an acid solution is determined by its ionization characteristic—(pH value) and not by the total acid present.

It is frequently the case that a water is simultaneously alkaline and acid. When such is the condition, the acidity of the water is a *qualitative* property, whereas the alkalinity is a *quantitative* characteristic usually expressed as grains per gallon or as parts per million. The quantitative or *potential* alkalinity is customarily determined by titration with standard acids whereas the qualitative or *dynamic* alkalinity is determined by measurement of the ion concentration. If it so happens that a water or any other solution has a measurable alkalinity as found by titration it is considered in the light of older conceptions as being alkaline. If, however, it happens that the determination of the hydrogen ion concentration (pH value) indicates a greater concentration of the hydrogen ions than of the alkali or hydroxyl ions, the solution is *qualitatively* acid. This explains why waters capable of neutralizing acids will at the same time attack limestone and dissolve metals. Such waters are termed "aggressive" waters.

Without entering too much into detail, it should be explained that the term pH value, such as pH5, pH6, etc., was coined for the purpose of plotting hydrogen ion concentration values on a more appropriate scale than could be done with the unwieldy figures showing the grams per liter of ionized hydrogen present. For example, the hydrogen ion concentration for pure water is 0.0000001 gram per liter, which, converted to the term pH value, is 7.0. The hydrogen ion concentration in grams per liter of ionized hydrogen in a tenth normal (N/10) hydrochloric acid solution is 0.1 and the pH is 1.00. In other words, pH is the logarithm of the reciprocal

of the hydrogen ion concentration—i. e., $\text{pH} = \log \frac{1}{\text{H}^+}$.

Table 1 shows the relationship between pH, strength in terms of normality, and the grams of ionized hydrogen per liter in solutions of acids or alkalis which are 100 per cent. or thereabouts ionized.

TABLE 1

	pH	Normality	Grams per liter of H
Alkaline	14.0	N/1 (Alkali)	0.00000000000001
	13.0	N/10	0.0000000000001
	12.0	N/100	0.0000000000001
	11.0	N/1000	0.000000000001
	10.0	N/10000	0.0000000001
	9.0	N/100000	0.000000001
	8.0	N/1000000	0.00000001

Neutral	7.0	N/10000000 (Neutral)	0.0000001
	6.0	N/1000000	0.000001
	5.0	N/100000	0.00001
	4.0	N/10000	0.0001
	3.0	N/1000	0.001
	2.0	N/100	0.01
	1.0	N/10	0.1
	0.0	N/1 (Acid)	1.0

It is apparent that the use of pH7 to pH0 covers the acid range from neutrality to an acidity N/1, whereas pH7 to pH14 covers the alkaline range from neutrality to an alkalinity of N/1; pH7 being that of pure water in both ranges.

DETERMINATION OF HYDROGEN ION CONCENTRATION

a. *The Electrometric Method*: If one vessel is filled with a solution containing a known concentration of hydrogen ions and a second vessel connected to the first is filled with the solution whose hydrogen ion content is to be determined and an electrode of platinum black kept saturated with hydrogen gas be immersed in each solution, a measurable difference of electrical potential will be set up between the two electrodes. This potential is dependent upon the concentration of hydrogen ions, just as the potential difference between a silver electrode and a solution of silver salt is dependent upon the concentration of silver ions.

By measuring the potential difference (E. M. F.) between the standard solution of known H. I. C. and the unknown, the H. I. C. of the unknown may be calculated.

Although the equipment actually used is not that described, such is illustrative of the principle of the apparatus and the procedure actually used. In practice one hydrogen electrode is immersed in the unknown solution, and as a substitute for the half-cell containing a solution of known H. I. C. and an electrode, a mercury-calomel cell which has been calibrated against a standard solution of known H. I. C. is employed.

b. *The Colorimetric Method*: Fortunately there is a method for determining the hydrogen ion concentration of a solution, which, while not so accurate as the electrometric method, is sufficiently exact for practical application and has the advantage of being rapid and requires but simple apparatus and manipulation.

The method is based upon the gradual change of color of certain dyes used as indicators. These dyes are weak organic acids which, when dissociated, have a different color from that of the undissociated dye. Methyl orange, for example, is yellow in alkaline solution and red in acid solution. In alkaline solution it is present as a salt and therefore becomes dissociated, the yellow color being caused by the anion of the salt. In acid solution the hydrogen ions of the acid present diminish the dissociation of this weakly acid indicator just as hydrochloric acid diminishes the dissociation of acetic acid. The undissociated methyl orange produces the characteristic reddish color indicating an acid reaction of the solution.

Since mixtures of the undissociated or acid methyl orange (which is red) and the dissociated salt of methyl orange (which is yellow) in varying proportions correspond to definite ion concentrations and since the shade of orange produced is proportional to the quantity of hydrogen ions present, each dif-

ferent tint represents a definite hydrogen ion concentration. This principle is the basis for the colorimetric method of determining the pH value of solutions.

A list of the most useful indicators used for determining the pH value of solutions colorimetrically is given in the following table, with the range of pH value through which there is a color change.

Indicator	Color Change	pH range
Thymol blue (acid range)	Red to orange	1.2-2.8
Brom phenol blue	Yellow to purple	3.0-4.6
Methyl red	Red to yellow	4.4-6.0
Brom cresol purple	Buff to purple	5.4-7.0
Brom thymol blue	Yellow to blue	6.0-7.6
Phenol red	Flesh to red	6.6-8.2
Cresol red	Flesh to red	7.2-8.8
Thymol blue	Straw to blue	8.2-9.8

For application in the laboratory or at the water works plant the most useful indicators for pH determination are the following:

Indicator	pH range
Brom cresol green	4.2-5.4
Brom cresol purple	5.4-6.0
Brom thymol blue	6.0-7.6
Phenol red	6.8-8.4
Thymol blue	8.4-9.8
Phenolphthalein	8.4-9.8

The procedure followed in determining the pH value of a solution or water sample consists of addition of exactly 0.5 c. c. of the prepared indicator solution to 10 c. c. of the unknown solution or water sample in a test tube or bottle.

Within a few seconds the color should be compared with a series of standard colors representing definite pH values. Such standards are prepared from combinations of acid and basic salts, the proportion of each being varied to produce the desired pH value. Exact methods for preparing the pH standards and the indicator solutions are given in the Am. Pub. Health Assn. "Standard Methods of Water Analysis."

If desired, the entire range of pH color standards or any part of it, together with the properly prepared indicator solution may be purchased from laboratory supply houses or the LaMotte Chemical Co., of Baltimore, Md. Such standards are supplied in sealed glass ampoules. The Brom Thymol Blue and Phenol Red standards appear to hold up better than the others. Where a laboratory is available, the standards and solutions should be prepared from purchased dyes and such standards renewed as frequently as necessary.

ROLE PLAYED BY pH IN PRACTICAL FILTER PLANT OPERATION

a. *Effective Coagulation with Alum*: The resulting hydrogen ion concentration of the water after the addition of alum is usually of considerable importance in the formation and precipitation of aluminum hydroxide "floc." In most instances the correct adjustment of the pH value of the treated water should permit of a substantial economy in alum required for satisfactory clarification.

Although experimental work indicated a final pH of 5.5 to be the optimum for alum precipitation in an artificially prepared water (and later work showed this to be true also for some natural waters), this has not been found to be universally the proper pH to create for the best coagulation with all types of waters. As an example—it appears that the optimum

for at least one highly colored swampy water in the South is not far from pH 4.0, whereas some of the Northern waters from the Great Lakes, which are semi-hard but relatively clear and colorless, coagulate satisfactorily at a pH of 7.2 or thereabouts. Again, there are instances of limestone waters, which coagulate satisfactorily at a final pH of 8.0.

At the time when the pH theory of optimum coagulation was brought out, many assumed this was to be a panacea for all of the difficulties which are frequently encountered in obtaining satisfactory coagulation and subsequent purification. Such persons have been disappointed in a number of instances but, on the other hand, there are many who have found coagulation much more readily controlled through use of the pH index than was possible in the past with the old methods of controlling, in which it had always been supposed that a definite excess of alkalinity should be maintained regardless of all else.

In one or two instances there have appeared seasons of the year when even the previously heterodox idea of adding acid to the water along with the alum has been practiced with resulting economy of alum and likewise superior coagulation. In certain instances it has appeared that the relatively large quantities of alum necessary at times in the past were mainly of value in supplying the acidity necessary to reduce the pH of the water so that the aluminum hydroxide would properly coagulate.

The old idea that the quantity of alum necessary was related only to the quantity of suspended matter, turbidity or coloring matter present has been proven a false one. The pH theory explained in a great measure why different waters with practically the same degree of turbidity produced in some instances good coagulation and in others very poor coagulation when the same charge of alum had been applied to each. In other words, waters of like turbidity, but varying pH value, require differing alum dosages; the pH controlling rather than the turbidity, in many cases.

The old idea, that when coagulating highly organic-colored waters the added alkali required to preserve a definite excess alkalinity resulted in the so-called "setting" of the color to an extent that it could not be removed by the alum "floc," has been proven erroneous. The alkalinity added was responsible for poor results, it is true, but the result appears to be due to peptization and re-solution of the aluminum hydroxide, with consequent release of coloring matter when the pH of the coagulated water is not maintained sufficiently low.

It is now considered the best practice in treating highly colored waters to add only sufficient alkali to avoid entire absence of titratable alkalinity after the alum is applied. The hydrogen ion concentration in such instances for optimum coagulation will be found usually within the zone pH 5.0 to pH 6.0. The filtered water will, of course, be very "aggressive." This condition must be corrected by aeration, the addition of artificial alkalinity, or perhaps a combination of both measures, to raise the pH value and reduce corrosiveness.

This same practice applies also to waters of low alkalinity and high turbidity without organic coloring matter. It has also proven feasible in some instances,

as mentioned previously, to add sulphuric acid along with the alum for best coagulation in cases where the water is fairly alkaline or has a relatively high pH value. The zone of best coagulation for turbid waters appear to lie between pH 6.0 and pH 7.0. As a general rule, the higher the turbidity with consequent lowering of alkalinity by the rainfall on the water shed, the nearer is pH 6.0 approached for optimum coagulation. In some instances acceptable coagulation of turbid waters has been obtained at a pH even less than 6.0.

In addition to the acidity supplied by the alum, the liberation of carbon dioxide during the reaction is of considerable importance in increasing hydrogen concentration. Below pH 5.7, the carbon dioxide content is not an important element in further reducing the pH value and acid or alum must be relied upon.

The temperature of the water to some extent has an effect upon coagulation. It has been shown that in certain cases the proper adjustment of pH value speeds up the retarded coagulation during low temperatures.

The points of greatest interest and importance in the relationship of pH to coagulation seem to be:

(1) There exists a pH zone for optimum coagulation which is fairly definite for a given water, or as the case sometimes is, for a given water during a given season of the year.

(2) The old idea of maintaining a titratable alkalinity of *not less than 10 parts per million* in the filtered water (assuming an even greater alkalinity would result in less danger of alum passing through the filters) is fallacious. On the contrary, the most effective precipitation of alum is produced in many instances only when the residual alkalinity is kept at a minimum.

(3) Specifications calling for a "basic" alum from the manufacturers are not warranted. On the contrary, the use of an acid alum, all other properties being equal, would have been more economical at a number of water plants.

(4) Sulphuric acid may be used at certain plants to reduce the alum necessary for good coagulation and, as has been recently brought out, the sulphate ion (SO_4) in itself has a very important bearing on efficient coagulation by alum or iron-sulphate. With an increasing quantity of sulphate ions it appears possible to obtain greater alum economy and superior coagulation, no matter whether the (SO_4) be added in the form of the acid or as a salt such as sodium or calcium sulphate.

Finally: In water purification, there are at least three chemical factors necessary for successful coagulation and clarification when filter alum is used:

(1) There must be added a certain minimum quantity of aluminum ion, i. e., alum.

(2) There must be present an anion of strong coagulating power, such as the sulphate ion.

(3) The hydrogen ion concentration must be properly adjusted.

a. For soft, highly colored organic waters, the zone between pH 5.5 and 6.5 appears most suitable for optimum coagulation by alum.

b. For semi-hard waters of low organic content

but subject to high turbidities at times, the zone lies usually between pH 6.0 and pH 7.0.

c. For hard or semi-hard fairly clear waters the zone seems to lie between pH 7.0 and pH 8.0 for acceptable coagulation although aluminum in solution may be found in the plant effluent to a small extent.

SOFTENING OR COAGULATION USING IRON SULPHATE

Data indicating the role of hydrogen ion concentration in softening practice and coagulation with sulphate of iron plus lime are limited. At the present time, studies are being carried on along these lines by a few observers.

In softening practice, calcium carbonate (CaCO_3) begins to form at pH 7.4 and is complete at pH 9.5. Magnesium hydroxide ($\text{Mg}(\text{OH})_2$) begins to form at pH 9.0 and is complete at pH 10.6. The minimum solubility of calcium carbonate at pH 8 is 60 p. p. m., while at pH 10 the minimum solubility is only 16 p. p. m. at ordinary temperatures. It is therefore apparent that the pH value of the treated water should have a material effect, other things being equal, upon the degree of hardness of the final plant effluent.

It has been proven beneficial in softening practice to raise the hydrogen ion concentration in the treated and settled water at a point just prior to its passage through the filters. This is done mainly to obtain coagulation of the non-settling or colloid-like hardness remaining in suspension. At the same time the solubility of the residual hardness is increased, thereby preventing incrustation of the sand and also incrustation within the mains and services. To obtain this end, carbonic acid gas (carbon dioxide) is bubbled upward through the water shortly before it enters the filters. Just what part the mechanical action due to the agitation by the gas bubbles plays and what part is due to the pH adjustment has not been conclusively shown. It appears, however, that carbon dioxide is considerably superior to air in this process.

Application of iron sulphate to the raw water prior to addition of the softening agents produces a similar effect to that of carbonation but probably to a lesser degree. Alum and sodium aluminate produce similar effects but to a lesser degree than a like quantity of iron sulphate. Since the solubility of alumina is very great in the pH zone of effective softening, aluminum compounds have the disadvantage of being materially less economical than iron sulphate and also produce a purified water containing aluminum in solution.

The production of the most satisfactory floc from iron sulphate and lime when turbidity removal is the prime object seems to be in most cases at a residual normal carbonate (CaCO_3) alkalinity of 30 parts per million. It would therefore appear that pH value possibly plays some fairly definite role in coagulation by iron sulphate also.

REDUCTION OF AGGRESSIVITY OF THE FINISHED WATER

The reduction of the hydrogen ion concentration, i. e., the raising of the pH value of certain waters, is one of the simplest remedies for reducing their corrosive character.

There are four main characteristics which enter in to control the aggressivity or corrosiveness of a

water, viz., (1) the dissolved oxygen content, (2) the hydrogen ion concentration, (3) the presence of material in solution or in suspension capable of forming a protective coating over the metal exposed, and (4) the temperature.

Dissolved oxygen is apparently the most serious offender, other things being equal. The pH value of the water is of course highly important since it has a decidedly retarding effect on corrosivity if carried sufficiently high. This therefore, may be the simplest method of correction to offset the oxygen present. At pH 10 and above, corrosion is materially retarded. The property of a clear water to deposit a protective mineral coating is directly dependent upon the material in solution and the pH. Above pH 10, ferric hydroxide is deposited as a protective coating and ferrous compounds cannot remain in solution; therefore dissolving of the metal by the water ceases.

Where it is not practical to remove the oxygen or to regulate the temperature, the control of the pH value of the water is usually the most practical method of reducing corrosion, and the practice of adjusting the pH of filtered water to reduce corrosion is rapidly increasing. To do this, the operators are given two pH standards in bottles or tubes, with instructions that lime or soda, as the case may be, shall be applied to the water leaving the plant in amounts so that the color test with the indicator will fall between the two standards. Whether the pH is to be 8.5, or some higher figure, will depend upon the other characteristics of the water, viz., oxygen, temperature and calcium content. In practice it has been found that ordinarily the maintenance of a pH of 8.2 or slightly above, (i. e., definitely pink when phenolphthalein is added), has proven highly beneficial and complaints of "red water" troubles due to corrosion have ceased.

SEWAGE SLUDGE CONDITIONING AND PRECIPITATION OF TANNIN FROM TAN LIQUORS

At a few places, notably Milwaukee, there has been carried on sufficient experimental work on a small plant scale to warrant recommendation that the sewage sludge be adjusted to a pH of 4.4 or thereabouts for most economical sludge dewatering and pressing. The results obtained indicated an increase in efficiency of filtration to about 4,000%. The pH is reduced by adding sulphuric acid or alum. On the whole, the alum addition produces results superior to the acid, although there are certain periods of the year when sulphuric acid alone can be economically substituted for alum. At other times a mixture of the two is to be used, while under extreme conditions heat applied to the alum-treated sludge is necessary also.

The solubility of tannin in tan liquor appears to be definitely related to its hydrogen ion concentration. A normal liquor of about pH 4.6 value, if further acidified, will precipitate and clog filters. The addition of alkali to tan liquors first increases the solubility of tannin to a maximum in a zone of pH 8.2 to 9.2. The addition of more alkali produces a rapid precipitation which takes place at pH 10.5. As a result of this, one method of treatment of waste tan liquors consists of adding lime to obtain a pH greater than 10.5, then the addition of ferrous sulphate to aid the coagulation and precipitation.

RELATION OF pH TO IMHOFF TANK OPERATION

Research work on sewage treatment at the Plainfield, N. J., plant being conducted by the N. J. Sewage Experimental Station, has disclosed with a reasonable degree of certainty that the hydrogen ion concentration of the liquids in the digestion compartment of the tank controls the quality of digestion obtained. Poor digestion, as indicated by foaming of the Imhoff tanks, always occurs when pH values of the liquid surrounding the sludge are acid, i. e., below pH 7. Foaming subsides when the liquid is alkaline, i. e., above pH 7.

In view of such observations it has been possible at Plainfield to materially reduce foaming conditions or avoid them to a considerable extent by correcting the pH value with lime. Lime added to maintain a pH of 7.6 in the digestion chamber will create a condition wherein the tank will handle a greater quantity of fresh or partially digested sewage solids than otherwise could be done without producing serious foaming. If, however, too great a quantity of lime is added, a pH value is created which is conducive to "alkaline foaming" which, although non-odorous, is even more violent than "acid" foaming. Dr. Willem Rudolfs and John R. Downs are to publish the results of recent experiments wherein lime was used to advantage in the control of foaming. The control of the pH value within the range 7.4 to 7.8 apparently relieves foaming markedly and permits a greater load of fresh sewage solids within the tanks than otherwise would be possible. In view of the fact that the details have not yet been published they will not be presented here.

At the Pennypack Creek Imhoff tanks at Philadelphia, H. M. Beaumont, engineer in charge of sewage disposal, has been applying lime to the sludge compartments daily for a number of years with success. The lime is added only when foaming is apparently beginning; when conditions have returned to normal it is discontinued.

In the case of water purification, effective coagulation always has been dependent in a large measure upon maintaining the proper pH value of the water, although it was not a recognized fact until within recent years. It now appears that the success or failure of lime as a benefit in improving Imhoff tank performance has depended upon the pH value produced. Not until the work of the N. J. Experimental Station has there been an explanation as to why the lime produced effective results in some cases and in others only aggravated the condition. The answer appears to be that the proper pH value was obtained experimentally or by chance in the one case, and in the other an excess of lime produced the more violent "alkaline" foaming, due to the too high pH value obtained.

CONTROL OF pH BY LIQUID CHLORINE . . .

The application of chlorine to raw waters prior to the addition of alum in filtration practice has within the past few years been proving advantageous in certain instances, notably the filtration of colored organic waters.

Where chlorine is applied it appears to lower the pH without changing the titratable alkalinity. It has been found possible in several instances to effect a reduced alum requirement by applying chlorine prior

to the alum; or, where this has not been practicable, it has been applied at the same point at which the alum mixes with the water.

This increased efficiency does not appear to be entirely due to the pH reduction but this phase more than likely plays a certain part in the process. It has been assumed that the chlorine artificially ages the coloring matter and the adjustment of the molecular structure of the organic colloid may be responsible for the increased ease with which it coagulates. Another possibility is that the chlorine neutralizes the charge on the colloid, thereby allowing it to more readily coagulate.

In practically all instances where colored waters have been pre-chlorinated, the efficiency of impurity removal by coagulation and filtration has shown improvement with an attendant over-all saving in the cost of treatment. One notable phase is the reduction in volume of wash water required to keep the filters in good condition and deliver the required water.

Sanitary Control of Ground Water Supplies

At the conference of State Sanitary Engineers, the Committee on Sanitary Control in the Development of Ground Water Supplies, consisting of H. J. Darcey, E. L. Filby, H. V. Pedersen, E. D. Rich, E. S. Tisdale and George W. Putnam, prefaced its report with the following code of principles:

GENERAL

1. Sources of ground water supplies should be located so as to prevent their contamination by surface drainage, flooding at times of high water, and by pollution resulting from proximity to sewers, privy vaults, cesspools, sewage wells, other leaching devices for sewage, streams, abandoned uncapped wells, sinkholes, etc.

2. Suction and gravity piping should be constructed with water-tight material and joints preferably cast iron and never sewer pipe. These lines should be located at a safe distance from sources of pollution and tested frequently to determine their tightness.

3. Collecting or storage reservoirs and suction wells should be carefully located, constructed waterproof, and covered. All manholes, vents and overflow openings should be properly protected from dust, small animals, and willful pollution.

4. All connections between a safe source of supply and a polluted water supply should be effectively eliminated.

WELLS

5. Well supplies should be protected from contamination at the surface by the following safeguards:

(a) A well pit or subground level pump room should be avoided wherever practicable and the pumps installed on a pump room floor located above the surrounding ground level.

(b) If conditions necessitate the installation of a well pit or subground level pump room the floor and wells should be made watertight, and a drain to an open outlet (under no condition connected to a sewer), or a pump and automatic ejector should be provided to remove the waste water.

(c) The outside casing or curbing of wells should be extended above the level of the ground or floor

of the pump room or pit, and a watertight connection installed to close the annular opening between the well casing and pump column or drop pipe. Dug wells should be provided with a watertight cover, and the pump pipe, manhole and other openings should be properly protected so as to prevent waste water or other contaminating material from entering the well. Pumping equipment should not be installed in the well in a manner requiring entrance of an attendant.

(d) On air lift pumping systems, the air inlet should be properly located and protected to minimize the entrance of dust and other contaminating materials.

(6) Well supplies should be protected from underground contamination by the following safeguards:

(a) A watertight outside casing or curbing should be installed, extending deep enough to prevent contaminated surface or shallow ground water or other pollution from entering the well through strata such as coarse gravel and limestone containing fissures, openings and solution channels. The bottom of the casing or curbing should be effectively sealed into a solid formation, and thoroughly tested to make certain that contaminated water on the outside of the casing cannot enter the well.

(b) Wells installed with a gravel wall should be protected by forcing into the space between the outside casing and well hole sufficient puddled clay to give a protective clay depth of at least 12 feet below the ground surface or any strata carrying contaminated water.

(c) Where the water is known or suspected of being corrosive, a metal well casing should be protected by providing a shell of cement grout at least 2 inches thick around same. An alternate method, suitable in some instances, is the use of a casing consisting of cast iron or best grade strictly wrought iron pipe with a double coating of bituminous material.

(d) A separate suction or discharge pipe should be installed inside a well casing in all instances, whether the well is to be pumped by suction, air lift or deep well pump.

7. Continuous purification or treatment should be provided to suit the circumstances where wells are not provided with the required sanitary safeguards, as outlined above, or where bacteriological or chemical tests, or other conditions indicate that contamination is reaching the water bearing strata.

SPRINGS

8. Springs should be protected from surface contamination by a waterproof concrete curbing and top. Springs which show analytical or field evidence of underground contamination with surface water or sewage should be effectively purified or treated.

MINE WATER

9. Water from mines subject to contamination or pollution requires adequate purification or treatment to make a safe supply. Special water supply drifts located in mines should be protected from flooding and drainage from working shafts and drifts.

INFILTRATION GALLERIES

10. Water from infiltration galleries should receive suitable purification or treatment unless located and operated such that satisfactory bacterial removal is secured.

PUBLIC WORKS

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Belt Conveying in Construction Work

Gravel, dug from the bank by a steam shovel and deposited in a hopper, flows in a continuous, uniform stream upon a belt conveyor, is fed automatically from one conveyor to another and is thus carried more than four thousand feet and up a hill to a screen; the screened gravel and sand are fed by belts to the mixer, as is also the cement, and the mixed concrete is carried by belt more than three-quarters of a

mile and deposited into forms. No human labor is employed in handling the gravel from bank to concrete form except the operators of the steam shovel, screen and mixer. And this system has a capacity of about two thousand cubic yards in an eight-hour day. It would take a large fleet of trucks to handle this amount of material.

This in brief describes part of what is believed to be the largest belt-conveyor installation ever used on a construction project—that employed in building the dams of the Wanaque reservoir, described in this issue.

Another use of belt conveyor on a much smaller job is also described in page 383. A series of four conveyors carried slag from the railroad and distributed it uniformly in a series of sludge beds more than 800 feet long, with practically no labor except that required to move the portable conveyors from time to time.

Use of such conveyors on construction work has been increasing for several years past. When, three and a half years ago, we described the use of a single run 600 feet long for carrying soil down hill for embankment in the Gilboa dam construction, the idea was comparatively new. With developments which permit conveying up as well as down hill and making any number of turns, the advantages of belt conveying are evident, especially when labor is scarce and highly paid. Material can be brought any distance desired and over or under streams, railways or other obstructions to truck hauling. A belt traveling at the rate of a fast walk will deliver more than two hundred cubic yards an hour, and one mechanic can easily keep the entire equipment in good operating condition.

Such conveyors of course have their limitations. They cannot handle large units such as blocks of stone. They are fully economical only where the material is to be transported at a comparatively uniform rate continuously throughout a period sufficiently long to warrant the expense of installation, or, if portable conveyors are used, the cost of carrying them to and from the job. But they offer a type of equipment that every contractor should consider in planning the transportation of material.

Air Mail

We have been asked by the Post Office Department to aid in giving publicity to the advantages of the air mail service that it offers. Perhaps we can best do so by citing a recent experience. One afternoon we received at our New York office a telegram from our Chicago office asking for information to be telegraphed on by night letter, for use the following morning. Instead we sent a two-page letter by air mail, which reached our Chicago office by the first delivery the following morning. In this way we made our communication as long as we desired, avoided possible mistakes in transmission, and at a cost only a fraction of that of a night letter.

The air mail offers possibilities of such service between most of the leading cities. It is especially valuable where actual documents, signatures, checks, etc., must be sent for the speediest possible delivery. The extra postage charge is negligible.

Residential Street Lighting

How twelve lighting experts proposed to light a residential street, no two agreeing in all details. Kind, weight and spacing of lamps, distribution system and fixtures.

A few weeks ago the Illuminating Engineering Society asked a selected list of engineers throughout the country who are interested in street lighting to prepare solutions of a special problem in street lighting that was presented in detail. Twelve solutions were received and coordinated by the Committee on Papers, and incorporated in a symposium that was presented at the annual convention of the society in September.

The street was assumed to be a typical residence street in a city of over 100,000 population, one-half mile long, 60 feet between property lines and 30 feet between curbs, paved with sheet asphalt. The sidewalk is 5 feet wide with 10 feet of grass plot between it and the curb. A photograph of the street shows trees (apparently maples, elms and oaks) in the grass plots at about 40-foot intervals, with foliage trimmed up to about 10 feet. The houses, which are of the better class, are located 35 feet back from the property line. There are wooden poles on the rear lot lines, 150 feet from the curb, which carry telephone wires, house lighting 115-volt distribution and 2300-volt, 3 phase, primary feeders. The street carries the typical residence street traffic, consisting of pleasure vehicles and delivery wagons.

Those replying were asked to state the amount of illumination recommended, in foot-candles or lumens; type and size of lamp; whether underground or overhead circuit; whether lamps on one or both sides of street or center span; distance between lamps; description of fixture and post, and of circuit.

Solutions were presented by T. P. Brown, street lighting specialist with the Edison Lamp Works; James R. Cravath, president of the Pioneer Electric Co.; W. T. Dempsey, superintendent, Service Maintenance Division, New York Edison Co.; A. F. Dickerson, chief engineer, Illuminating Engineering Laboratory, General Electric Co.; O. F. Haas, illuminating engineer, National Lamp Works of General Electric Co.; Robert J. Malcomson, street lighting engineer, Public Service Co. of Northern Illinois; G. E. Miller, sales manager, Cleveland Electric Illuminating Co.; R. B. Patterson, superintendent of Distribution Dept., Potomac Electric Power Co.; T. W. Ralph, managing engineer Street Lighting Dept., Holophane Glass Co.; R. D. Whitney, electrical and illuminating engineer, Crouse-Hinds Co.; L. A. S. Wood, manager Street Lighting Section, Westinghouse Electric

& Mfg. Co.; T. H. Yawger, superintendent Electrical Dept., Rochester Gas & Electric Corporation.

While each gave his idea of what the city should spend per running mile as an annual charge, including fixed charges, it was decided not to report these estimates in dollars, but in percentages of the average. These varied between 222% by Mr. Wood and 38% by Mr. Ralph; the former recommending .25 foot-candles average illumination, the latter .10 foot-candles.

Series incandescent lamps were recommended by 10, multiple incandescent lamps by 2. The lumen output (10 times nominal horizontal c.p.) varied from 2,000 to 4,000, six specifying 2500 and three 4000; and for amperes seven recommended 6.6, one 7.5, and two 15.

The illumination values varied from 13 lumens per foot to 50, most of them between 20 and 25. Mr. Patterson recommended 22, with 55 at street crossings.

In arrangement and spacing of lamps, only one recommended placing on one side of the street only, (with 196 feet spacing), one the center span, (with 273 feet spacing), and ten staggered. The spacing for staggered location varied from 80 feet (using 4000 lumen lamps) to 155 (using 3250 lumen lamps.)

The mounting heights ranged from 11 feet to 16 feet, except the center span for which 25 feet was recommended. The average, omitting the center span, was 13½ feet.

For distribution system, series underground, insulating transformers, was recommended by three; series underground, film cut-outs by six; multiple underground, clock or remote control by one; multiple underground, pilot wire control by one; and series overhead, film cut-outs by one.

In the matter of fixtures, rippled alabaster globe and canopy, dome refractor, was recommended by one, without the refractor by one, and without the canopy by one. Others recommended an ornamental lantern, one with asymmetric refractor, another with dome refractor, a third with refractor (type not specified.) Other types were: "Ornamental, post top, refractor type." "Copper casing, porcelain reflector, diffusing globe." "Ornamental pendant, dome refractor." "Pendant, diffusing." "Ornamental reflector without globe; frosted lamp." The center span lamp would be "non-ornamental; 4-way 2-way refractor."

The least expensive of these was the center span lamp, 4,000 lumens, 273 feet spacing, giving an average of .10 foot-candle with a minimum of .03; a non-ornamental lamp supported by mast arm or span wire from a wooden pole, with a series overhead distribution system.

The most expensive was an ornamental lantern with refractor on a reinforced concrete standard, spaced 80 feet apart staggered, of 4,000 lumens, giving 50 lumens per foot with a minimum of 0.20 foot-candle; the distribution system being series underground with film cut-out.

Meeting a Drought Emergency*

How the Water Department of Baltimore City met its emergency during the drought of June, 1925.

By V. Bernard Siems †

Notwithstanding the fact that 20 billion gallons of water was impounded behind our dam at Loch Raven, (on Gunpowder river) from which the city draws its water supply through a tunnel capable of delivering 240 million gallons per day; notwithstanding a filtration plant capacity of 128 million gallons plus 15 per cent overload and an average daily consumption which did not exceed 122 million gallons for the entire city, the service was seriously hampered and the public in certain sections inconvenienced by inadequate pressure during the drought of the recent season.

The month of June, 1925, was marked by a period of extreme drought and excessively high temperatures, continued for such a record-breaking length of time that the local branch of the U. S. Weather Bureau stated in a review of the conditions that "it is unlikely another such month would be experienced in Baltimore in a century." From June the first to June the twenty-second the mean temperature was almost eight degrees above normal and on thirteen days during this period the maximum temperatures were ninety degrees or more. The last week in May and the first three weeks in June had a total rainfall of only .27 inch. This combination of high temperatures and prolonged dry weather was an ideal one for imposing the maximum possible demand upon a water supply system.

The results of these conditions were immediately reflected in the water consumption, particularly in the closely populated suburban sections lying in the northern and northwestern portions of the city. Much of this territory was included in that annexed to the city in 1918, and was formerly supplied by private water companies whose distribution systems had already grown inadequate to meet the demands for domestic consumption. As this section was most suitable for suburban development its growth

was very rapid but had been anticipated by the Department in the construction of an additional 20 million gallon 3rd Service Zone reservoir at Pikesville and in the rehabilitation of the distribution systems of the private water companies, and the construction of additional feeder mains.

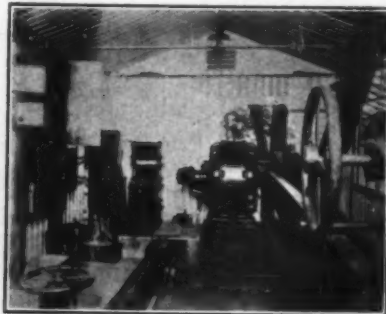
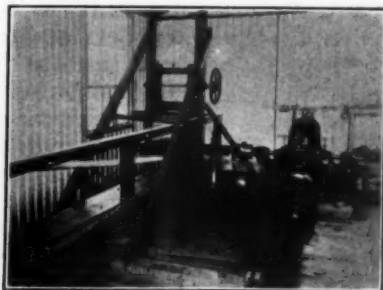
However, all of this work has not yet been completed and, moreover, large additional areas have been added to the distribution system through the establishment of the Baltimore County Metropolitan District, so that while the department would have been able ordinarily to have rendered satisfactory service during the summer months, the extreme weather experienced this year brought about a condition which rendered the water service difficult to maintain.

The increase in the water consumption of the districts mentioned was not of serious proportions when viewed on a twenty-four hour basis, being approximately twenty per cent for the Eastern 3rd Service Zone and twenty-five per cent for the Western 3rd Service Zone, but the peak demand that these two districts created in the early evening hours taxed our pumping equipment to its limits and the distributing facilities far beyond their capacities. In the north-western district of the Western 3rd Service Zone between 7:30 and 8:30 P. M. the demand for water was often more than three hundred per cent of the normal average consumption, and the peak demands in the Eastern 3rd Service Zone was not much less than this figure. Under these conditions, it was not surprising that a considerable portion of the territories using this excessive quantity of water suffered from a lack of adequate pressure at the time of maximum draft, although I am happy to be able to state that no area was completely out of water at any time.

For two months previous to June 1st, 1925, the Pikesville reservoir, on which the Western 3rd Service Zone is balanced, was out of service undergoing repairs and it was just starting to be filled when the hot spell unexpectedly came upon us. The first five days of June, with an average maximum temperature of ninety-six degrees, were sufficient to deplete the reserve that had been accumulated and for the remainder of the period of maximum consumption the water that was available from this source was only that which we were able to pump into the reservoir in excess of the consumption during

*Paper before New York Section, American Water Works Association.

†Water Engineer, Baltimore Department of Public Works.



BALTIMORE'S EMERGENCY PUMPING PLANT AND BUILDING IN WHICH IT WAS HOUSED.

the early morning and forenoon hours. In the Eastern 3rd Service Zone part of the system is balanced on a standpipe which has long since been outgrown by the consumption requirements of the district it serves, so this service was no better situated with reference to a reserve than was the Western 3rd Service Zone.

Both the Western and Eastern 3rd Service districts are normally supplied by the Druid pumping station, which takes suction from the Pimlico reservoir at which the station is located.

This reservoir, which was constructed about 1880, is of about 25 million gallons capacity; and at that time was used to furnish the 3rd Service Zone to the then small area within the limits of the 1888 Boundary Line needing it. With the gradual increase of consumers in the Western 2nd Service, this lake became inadequate and Lake Ashburton, or the Western 2nd Service reservoir, was constructed as the main supply for the zone, leaving Pimlico reservoir to serve merely as suction for the pumps at Druid pumping station, supplying both Eastern and Western 3rd Service Zones.

The draw on Pimlico reservoir caused by the excessive pumping demands was greater than the carrying capacity of the 30" supply main to the reservoir, resulting in the reservoir water level being drawn down so low as to necessitate throttling the discharge of the Western 3rd Service pumps to the point where the pumpage was not greater than the quantity of water flowing into the reservoir.

Apparently only eight or nine million gallons a day could be forced into Lake Pimlico; even with Mt. Royal or Western 2nd Service pumping station working at a 30 million rate, it steadily lost water.

This limitation was a serious handicap to the pumpage, as we were not able to operate these pumps to their capacity, and in order to alleviate this condition changes were made in the distribution system to throttle the flow to Ashburton reservoir and thus force more water into Pimlico reservoir. In addition, a 16-inch main into Pimlico, which had been shut off from this reservoir for a number of years, was placed back in service. These manipulations improved conditions somewhat, but there was still a deficiency in the flow to Pimlico reservoir, as is shown by the fact that the maximum permissible quantity drawn from the reservoir in any one day during the period under discussion was 11.27 million gallons, whereas the combined available capacity of the Eastern and Western 3rd Service Pumps is 15 million gallons daily. The average daily pumpage for both services from the Pimlico reservoir for this period—June 1st to June 21st, inclusive—was 8.8 million gallons, which is an index of the extent to which the insufficiency of water in the Pimlico reservoir handicapped the operation of the pumping units. (Determination of the maximum available capacity noted above—15 million gallons daily—is based upon the capacity of the new Western 3rd Service pumps,—10.5 million gallons daily—and the as-

sumption that we use the old Western 3rd Service pumps to discharge into the Eastern 3rd Service, with a maximum output of 4.5 million gallons daily.) In this connection it should be noted that although we have a maximum of 4.5 million gallons daily available for the Eastern 3rd Service, the lack of a reservoir in this district limits the amount of water that can be pumped during the day and made it practically necessary that the peak demand be met by direct pumpage, as the storage in the standpipe did not last more than thirty to forty-five minutes when the peak came on.

To increase the flow to the Eastern 3rd Service during the maximum draft, a division valve in the Druid or 3rd Service pumping station was operated to permit water to flow from the Western 3rd Service; this imposed a heavy draw on the Western Service and to compensate for this as far as possible water was supplied to the Western 3rd Service from an independent source, (Patapsco river) via Avalon, Catonsville, 4th Service Zone Standpipe (Ingleside) and Hillsdale pumping stations. The flow from this source amounted to approximately 1.14 million gallons daily and it was possible to use it only ten days between June 3rd and June 12th, as the filter beds at the Avalon filtration plant limited their capacity to such an extent as to make it impossible to maintain the water level in the Catonsville 3rd Service reservoir above the point where the pump suction would be impaired.

The changes in the distribution system to augment the flow into Pimlico reservoir, the use of Western 3rd Service to boost part of the Eastern 3rd Service supply, and the introduction of the Avalon-Catonsville-Hillsdale supply to increase the flow into the Western 3rd Service represented the maximum effort that could be made, with the available facilities, to meet the conditions confronting us, and the service which a large number of consumers were receiving, particularly part of the Eastern 3rd district, was far from satisfactory. Accordingly, it was decided on June 5th to install a temporary pumping station to supply the Eastern 3rd Service from a supply independent of the Ashburton-Pimlico reservoir system, using a 3 million gallon centrifugal pump which was suitable for the service proposed. This pump was the only equipment we had which could be used, making it necessary for us to obtain a motor and controller, arrange the pump for belt drive, and do all other work required to get the station in operation. Suction was taken from an Eastern 2nd Service Zone 36" supply main, the discharge being into a 16" Eastern 3rd Service Zone supply main, the two water main connections being within approximately two hundred feet of each other.

The pump was first turned over on June 9th, four days after work started, but due to trouble with the belt drive, was not put into actual service until June 12th, one week after the ground was broken. The delivery from this source was at the rate of about 2.90 million gallons daily

and the pump was operated daily continuously from early morning until about 11:00 P. M., the deficiency in the service being made up when necessary by operating at Druid pumping station.

The operation of the temporary station immediately relieved conditions in the Eastern 3rd Service, and with the removal of the load from the Druid 3rd Service pumping station, which the temporary station allowed, a betterment in the Western 3rd Service was soon noticed. By putting into the Western 3rd Service the water which had been going into the Eastern 3rd Service, we were enabled to gradually build up a reserve in Pikesville 3rd Service reservoir, and at the same time allow the Pimlico reservoir to return to normal, so that by the latter part of June all districts were being adequately supplied.

During the hot spell the levels in all the reservoirs of the department were very much lowered, Ashburton or Western 3rd Service reservoir being drawn down 10 feet, but not enough to cause any uneasiness, with the exception of Towson reservoir, supplying the extreme eastern 3rd Service Zone and for suction of the Pumping station for Eastern 4th Service Zone. Here the level became so low as to threaten the operation of the automatic pumping station located at the reservoir, and this required us to augment the service by the operation of the Mt. Washington pumping station. By this means the conditions at Towson were soon restored to normal, and this brought all of our difficulties due to the prolonged hot spell to a close.

During this emergency the engineers and workmen remained on their jobs voluntarily for long hours and without complaint, manifesting only interest in relieving the situation and indeed the excellent coordination of their work was responsible for the success with which the condition was handled.

Our analyses of the condition indicated that it was brought about by the excessive use of lawn sprinklers and hose connections for wetting down the pavements and sidewalks, and the increase in consumption was observed almost entirely in those suburban sections where the water supply services remain unmetered.

Inspectors of the department were sent into these zones to urge the conservation of water and the Police Department as well cooperated in discouraging waste, for sprinklers were found running twenty-four hours per day unattended. Notices were inserted in the newspapers restricting, by order of the Water Board, the use of hose connections during the mid portion of the day or that portion of the day in which the normal peaks are experienced and finally prohibiting their use altogether until the condition improved.

While it might be said that on the whole the people cooperated, considerable unfavorable comment resulted because of the inability of the people to understand, as was reasonable, why certain sections of the city should experience

slack water supply and be subject to restrictions in its use, while other sections of the city remained unrestricted, and while there was 20 billion gallons of water available behind the new dam at Loch Raven.

As this belief of the people could not be speedily altered and as Baltimore is practically an unmetered city (16% metered) we met the emergency in the only manner we thought practicable, that is, after trying educational and persuasive methods without success, by providing additional pumping facilities and letting them have all the water they wanted.

Hetch Hetchy Bay Crossing Division

Twenty miles of steel pipe, part on trestle and on a 36-span steel bridge and of submerged flexible joint pipe under water ways.

The San Francisco Bay Crossing Division of the Hetch Hetchy water supply project extends from what will be the Irvington gate house, to be located at the west portal of the coast range tunnel, to the outfall of Pulgas tunnel, where the water will discharge into Crystal Springs reservoir. The present installation will have a capacity of approximately 42 million gallons daily. It is proposed ultimately to construct three pipe lines on this right of way which is 60 to 100 feet wide. An arrangement was made by the city with the Spring Valley Water Company that the latter should use the bay crossing conduit immediately upon completion to convey water from its Alameda properties to Crystal Springs reservoir.

The bay crossing conduit is 19.4 miles long, not including the submarine siphons at Newark Slough and Dumbarton Strait. It is of riveted steel pipe 60 inches inside diameter and varying from 5/16 inch to 7/16 inch thick. For 1.7 miles east of Newark Slough it is carried on a timber trestle over a salt marsh. At Newark Slough there is 400 feet of 42-inch submarine type flexible-joint cast iron pipe. From Newark Slough to the east shore of Dumbarton Strait, a distance of 1.4 miles, the five-foot steel pipe continues



GENERAL VIEW OF 60" PIPE ON TRETTLE, NEWARK SLOUGH



CONCRETE ANCHOR AT EAST END OF SUBMARINE PIPE.

over the marsh on a timber trestle. The navigable channel at Dumbarton Strait is crossed by another 42-inch submarine siphon nearly 2800 feet long, ending at a concrete caisson 81.5 feet in diameter. The pipe rises up through this caisson to a steel bridge on which it is carried 3875 feet to the west shore of the strait and continues on a trestle 2700 feet to the Bay-Pulgas pumping station. From this point west, the pipe is buried. The steel pipe was manufactured by the Western Pipe and Steel Company for an

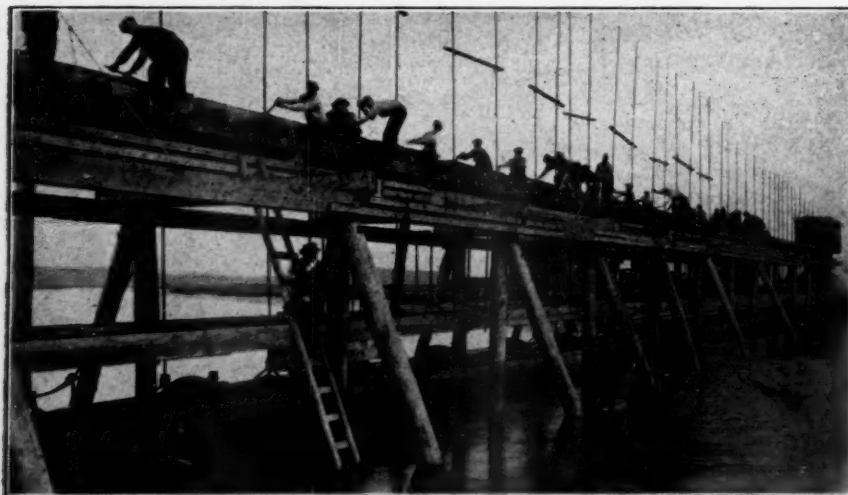


42" SUBMARINE PIPE RESTING ON TRESTLE AT EAST SIDE OF NEWARK SLOUGH.

estimated price of \$2,231,661; the flexible-joint pipe by the U. S. Cast Iron Pipe and Foundry Co. Pipe laying was begun on the west side of the Bay on October 20th, 1923.

NEWARK SLOUGH CROSSING

At the east end of the Newark Slough, where the 42-inch submarine pipe connects with the 60-inch riveted steel pipe, there is a concrete anchor, designed to receive the thrust of the pipe, about 28 feet long by 12 feet high. Rings of angle iron were riveted around the 60-inch pipe and im-



LOWERING 42" PIPE FROM TRESTLE.

bedded in the concrete to hold the pipe firmly in place. The anchor rests upon 44 piles, each about 65 feet long, which were driven with a batter of 1 to 3 to take the thrust of the pipe line.

The submarine pipe is 2 inches thick, in 12-foot lengths, with flexible joints allowing 10' 45" deflection at each joint. In laying the submarine pipe the first work to be done was the construction of a cradle which was supported by piling driven across the slough. This cradle was constructed so that it could easily be removed later. Heavy timbers were placed across the top of the piling and these in turn supported longitudinal timbers and steel rails laid upon them for carrying four-wheel trucks. Each section of submarine pipe was placed on a truck and run out over the slough, where it was picked up by means of a floating derrick and deposited in position on the cradle. The lead joint was then poured by means of a long pipe extending between the rails to the joint from a furnace mounted on a four-wheel truck travelling on the track. When a joint had been poured and caulked, two heavy steel bands were placed around the length of pipe, from which bands long threaded rods extended up through the heavy timbers. When the entire line had been caulked, the pipes were lowered by means of nuts on these threaded rods. The entire line of pipe was first raised from the cradle by means of these nuts operated by a crew of men, one to each rod; the cradle was then removed and the pipe was lowered into place in a trench dredged in the bottom of the bay, all the nuts being operated simultaneously.

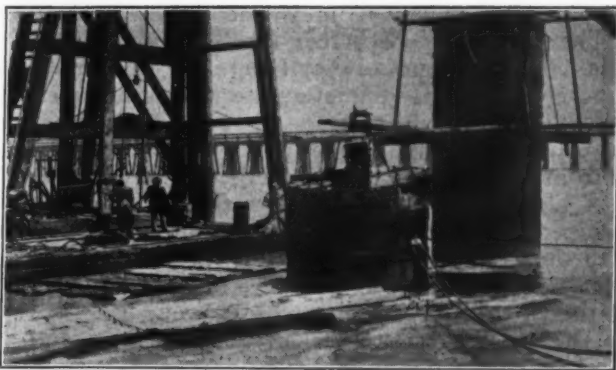
DUMBARTON STRAITS

This method could not be used in laying the flexible-joint pipe across the deep channel at Dumbarton Straits, but the contractors—The Healy-Tibbitts Construction Company—employed a 65-ton cradle approximately 165 feet long, which was attached to the end of the largest derrick barge on the Pacific coast. The pipes were joined in this cradle and, as the barge was towed across the channel, they slid out into position; the method being that employed in laying pipe to Staten Island, New York City, a few years ago.

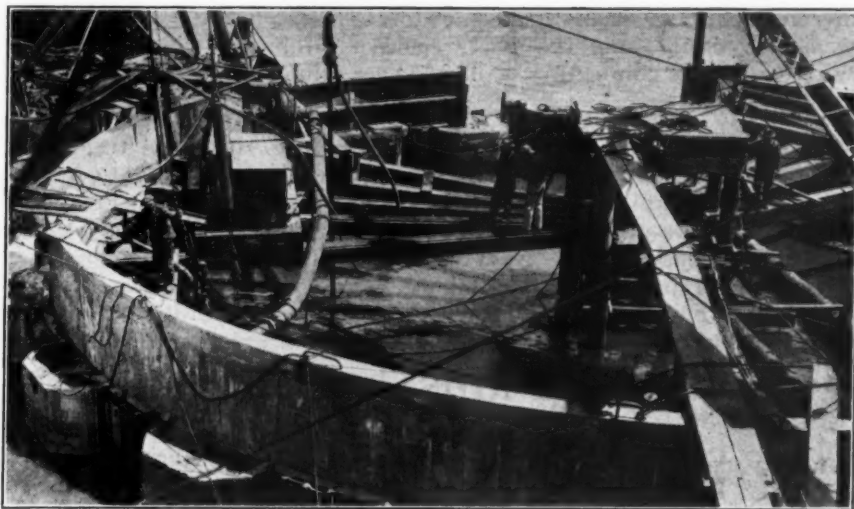
The bridge which carries the pipe lines over the shallow water on the west side of Dumbarton Straits consists of 36 steel spans, each 105 feet long, supported by 37 concrete piers, each consisting of two vertical cylinders of reinforced concrete connected by horizontal beams. In constructing these piers a cofferdam of wood or steel sheet piling was driven around the site of the pier and the mud within the cofferdam excavated to a depth of from 5

to 30 feet. From 52 to 60 piles were then driven into the bottom of the excavation, the water within the cofferdam was pumped out and the concrete foundation poured. In the case of two of the piers it was found impossible to pump out the cofferdam on account of excessive leakage and here a 6-foot bottom of concrete was laid by means of a tremie. When this concrete had set, it was possible to pump out the water above and construct the remainder of the pier in the dry.

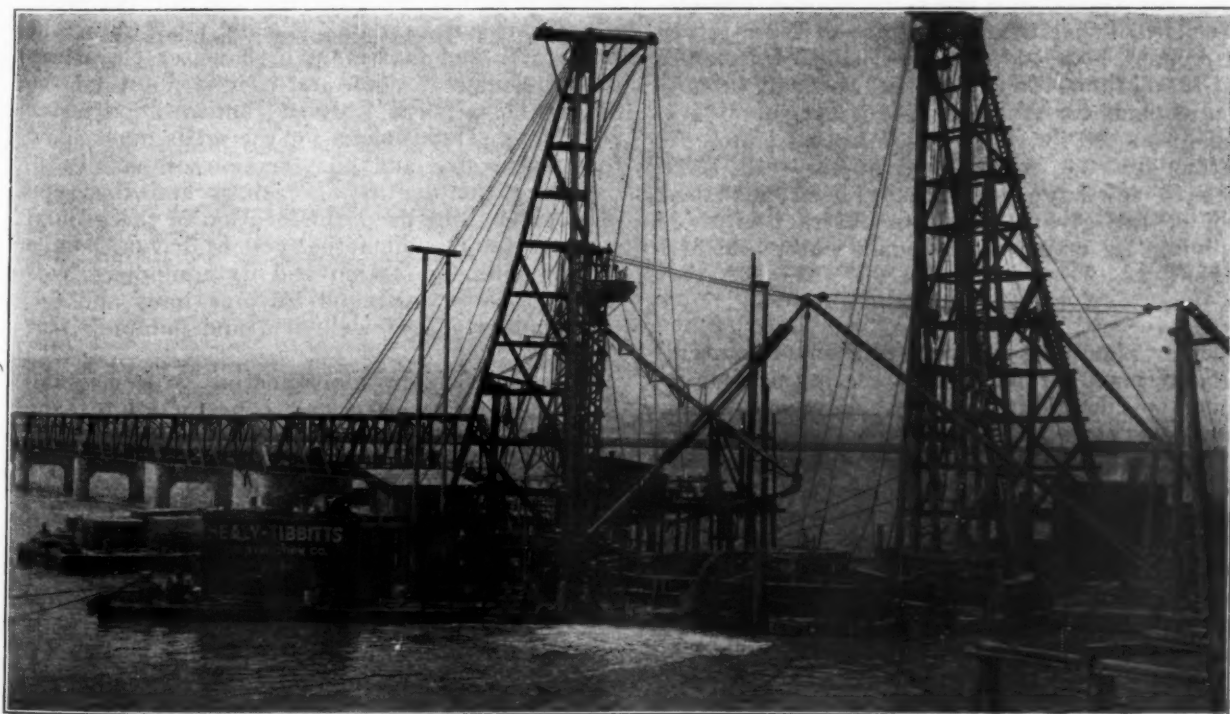
At the east end of the bridge is a large concrete caisson in which connection is made between the steel pipe on the bridge and the submarine siphon. This caisson is hexagonal in plan, 40 feet in the short diameter at the top and 81 feet 6 inches outside diameter at the base. The bottom of the central chamber, which is 24 feet in diameter, is about 27 feet below sea level and contains four vertical pipes forming the west end connections of the submarine system. Just below the mud line, four 42-inch cast iron pipes embedded in the concrete wall of the caisson provide connection to four 42-inch submarine pipes, only one of which will be used at present, the other three being provided for future connections to submarine lines to



STEEL CYLINDERS IN COFFERDAM FOR CAISSON.



CONSTRUCTION OF CAISSON UNDER WAY.



BUILDING CAISSON AT DUMBARTON BRIDGE.

Another span of bridge brought it to the caisson. From that span the pipe passes vertically through the caisson to the bottom of the bay and thence under the navigable channel.

be installed when it may become necessary.

The caisson is 77½ feet inside diameter. It was constructed of 24 cylinders of reinforced concrete, 6 feet in diameter, the spaces between which were closed by means of steel sheet piling. In order to receive the upward pressure at the bottom of the caisson, 10 feet of tremie concrete was placed there, after which the caisson was pumped dry. About 800 tons of reinforcing steel was then placed in position and the walls of the central chamber were poured. In setting each of the 24 cylinders used in constructing the wall of the caisson, a steel shell 85 feet long and weighing 30 tons was driven into the bottom of the strait. The sand was removed and 9 piles driven inside the cylinder. Precast reinforced concrete cylinders were then put down inside the steel cylinders and the latter removed; following which the connecting walls of sheet piling were driven.

BACKFILLING TRENCH

An interesting feature connected with the work of the Bay Crossing division was the appliance used in backfilling the pipe trench. It consisted of a cable-drawn shovel operated on an overhead track supported by a truss, the whole spanning both trench and spoil bank; one end of the truss being supported by the chassis of

a tractor and the other on a pair of wheels resting on the ground which were driven by an electric motor. The tractor, of the caterpillar type, moved forward parallel with the trench as it was fulfilled.

The trench had been excavated by means of



BACKFILLING PIPE TRENCH.

a drag line excavator, which had deposited the earth over a width of about 40 feet along the side of the trench. This earth was scraped back into the trench by means of the power grader which was operated back and forth along the truss by means of a cable. The current for driving the motor operating the cable and that operating the wheels which carried the further end of the truss was obtained from a generator mounted on the truck.

Waterworks Plans for New Jersey Municipalities

Changes in the rules and regulations of the State Department of Health governing the preparation and submission of plans for proposed water supply and purification works.

As was stated in a previous article, the Department of Health of the State of New Jersey on August 11th adopted a revision of its rules and regulations for the preparation and submission of plans for sewerage and water supply systems proposed for construction in that state. An abstract of the revised regulations with reference to sewerage has already been published, and we are giving below an abstract of those applying to water supply and water purification works.

INFORMATION REQUIRED

Under the head of "Information Required," the new matter called for by the regulations includes specifications for water lines and appurtenances; a map of the water shed if from a surface supply, or one showing the locations of wells or collecting galleries if such are proposed, and general and detail plans of the wells and collecting galleries. Also specifications for purification works or treatment processes, wells and collecting galleries, and their appurtenances; and estimates of costs of all parts of the systems. The map showing the wells or collecting galleries must show dwellings and streams within 500 feet of these and any storm or sanitary sewer lines, with type of construction, which may pass over or near the wells and galleries, and all other sanitary features.

The plan for the galleries, and for the wells if they are adjacent to a stream, must show the low water and maximum high water elevations of the stream if tidal, and if it is not tidal the normal elevation and highest known flood water elevations. Detail plans for the wells must show the depth, size and construction of each well, including the depths of casings and the type of strainer to be used, the location of the ground strata through which the well is driven, details of the pumping station and its equipment, collecting basins, etc., and all pipe lines and appurtenances at the well field and pumping station.

"The detail plans for collecting galleries shall show the depth, size and construction of the galleries and all details such as manholes, size of pipes, valves, etc."

The engineer's report must, if a surface supply is contemplated, give the results of chemical and bacteriological examinations of the raw water; the area, population and description of the water shed; and sources of pollution, including privately and publically owned sewage treatment plants discharging effluents into the source of supply and plants discharging industrial wastes, together with the protective measures to be installed or enforced for the protection of the supply, such as patrol, fishing and bathing regulations, etc. If the water is from an under-

ground source, information shall be given concerning the various strata and the probable quantity and quality of supply based on analysis or other available information regarding water from similar sources.

Plans for purification works must include a general plan showing the general layout of the various units, the piping systems, surface elevations of the various units, and the normal elevation and highest known flood water elevation of the stream. The detail plans must show complete details of each unit, including mixing chambers, collecting and piping systems, method of applying chemicals, rate controllers, loss-of-head gauges, washing arrangements, etc., and sizes and depth of stone, gravel and sand used for filtering material.

WATER PURIFICATION PLANTS

The requirements in full for water purification plants are quoted below from the revised regulations.

1. General:

- (a) A flow recording device must be installed to give a continuous record.
- (b) A laboratory is desirable and may be required for large plants. Routine testing equipment such as free chlorine apparatus, alkalinity outfit, etc., must be specified according to the character of the plant designed.
- (c) Sampling taps must be provided before and after each treatment unit.
- (d) The return to the system of any water used for cooling purposes, etc., will not be permitted.

2. Filtration

Surface Supplies.

(1-a) Slow Sand.

(a) At least two units are required, each capable of supplying the entire demand. If more than two are proposed, this requirement is waived, provided that when one filter is out of service, the other units are of sufficient size to supply the necessary amount of water at the proper rate.

(b) The rate shall not exceed 3,000,000 gallons per acre per day.

(c) The effective size of the sand shall be between .25 and .40 millimeters, the uniformity coefficient not over 2.0.

(d) The depth of sand shall be not less than 36 inches.

(e) At least 12 inches of graded gravel shall be placed over the underdrains.

(f) Covers for filters are desirable and will be required in northern sections.

(g) Sterilization as a final treatment is required.

(1-b) Rapid Sand.

(a) At least two units are required, each capable of supplying the entire demand. If more than two are proposed, this requirement is waived provided that when one filter is out of service, the other units are of sufficient size to supply the necessary amount of water at the proper rate.

(b) The rate shall not exceed 125,000,000 gallons per acre per day.

(c) Rate controllers are required.

(d) The effective size of the sand shall be between .30 and .50 millimeters, with a uniformity coefficient not over 1.6.

(e) The depth of sand shall be not less than 30 inches.

(f) At least 12 inches of graded gravel is required over underdrains.

(g) Coagulation and sedimentation must precede filtration, the coagulation basin to have a minimum of 4 hours detention. A baffled mixing tank shall precede the settling basin.

3. Iron Removal.

(a) Aeration, sedimentation, or chemical treatment, or combinations thereof, shall precede filtration for iron removal.

(b) Requirements for filtration shall be the same as for surface water filters, except that sterilization may ordinarily be omitted.

4. Sterilization.

(1-a) General:

(a) The building housing sterilization apparatus must be heated.

(1-b) Hypochlorite:

(a) Duplicate storage tanks are required, each to have a capacity for 24 hours' supply, based on a 2 per cent solution.

(b) A constant feed device is required, so constructed that it may be calibrated and checked.

(1-c) Liquid Chlorine:

(a) Duplicate apparatus or a supply of spare parts is required.

REQUIREMENTS FOR WELL SUPPLIES

(a) Subsurface construction must be such that no contamination can enter at joints or along the casing. Detailed drawings of the casing work are required.

(b) The well head and top of casing must be designed so as to prevent contamination from surface sources.

(c) Sampling taps must be provided on each well.

Weighing Concrete Pavement Aggregate

Comparison of results obtained in Iowa in measuring aggregates by volume and by weight. Average quality better when weighing is employed. Equipment used.

Although concrete aggregates are measured by volume in the majority of cases, the State Highway Commission of Iowa since 1923 has required that sand and stone be measured by weight and the results have been very gratifying. Measurement by volume is subject to certain inherent inaccuracies, especially if the measure box is not designed to be struck off. These include the bulking of the sand when damp, as referred to in our August issue. Another important effect has been the reduction in cement over-run. Out of forty-one contracts during 1920 to 1923, when aggregates were measured by volume, the maximum average over-run in cement for a season's work on one job was 7.22 percent, while the minimum was an under-run of 0.65 percent. During 1924, fourteen contracts, in which the aggregates were weighed, had a maximum over-run of 3.6 percent and a minimum of 0.7 percent. With rigid inspection the slab will always average a little thicker than is specified, so that some overrun is to be expected.

In comparing the quality of concrete, compression tests were made of cylinders two of which were molded each day on the construction. There was little change in the maximum range of strength due to change from volume to weighing, but the average strength per job was more uniform after the change and the strength of individual specimens is more uniformly concentrated near the average.

During 1924, fifteen outfits used weighing apparatus in constructing one hundred miles of concrete pavement. They used four general types of equipment: 1. A bottom dumping hopper with Toledo dial scale. 2. A bottom dump-

ing hopper hung on simple scale beam. 3 A bottom dumping hopper on platform scales. 4. A movable side dumping hopper on platform scale for loading industrial railway.

All of these worked satisfactorily, measuring materials as quickly as the old volume boxes, and requiring no extra men to operate them, and it was possible to weigh batches to within five pounds of the correct amount.

In a contract in Scott County, the sand and stone are delivered from bins, there being two measuring boxes under each bin. These boxes are hung on the short ends of scale beams, from the other ends of which long rods hang down to within easy reach of the scale man. The scale weights are placed on these rods, which also carry pointers which indicate when the beams are balanced. In weighing sand for a batch, the scale man removes part of the weight from the rod, lets in the sand rapidly until the scale beam roughly balances, then replaces the weights and lets sand in slowly until the beam just balances. The rough balance is made within about thirty-five pounds less than the full weight. Stone is weighed in the same way, except that the rough balance is made within about eighty-five pounds less than the full weight. If excess material enters the measuring box, it may be taken out through a waste chute. Two scale men can weigh the two batches of material while the cars are being spotted. Allowance is made for the weight of moisture in the material, the moisture content being determined by the plant inspector six or eight times a day and the scales adjusted by him accordingly. The scales are checked each day by placing standard weights on the measuring boxes and are checked for balance at zero load several times a day.

Colorado Maintenance Truck

The accompanying illustration shows a maintenance truck of the Colorado Highway Department which is equipped for repairing breaks in reinforced or plain concrete, macadam or other pavement, using pneumatic jackhammers, pneumatic air jet to blow out refuse, and a power-driven concrete mixer for

mixing concrete or bituminous materials, which are carried on the truck in bins. It also erects fences, using a pneumatic post hole digger, concrete mixer, tamping tool, and paint spray outfit for painting or fireproofing. A side arm can be used for stretching wire.

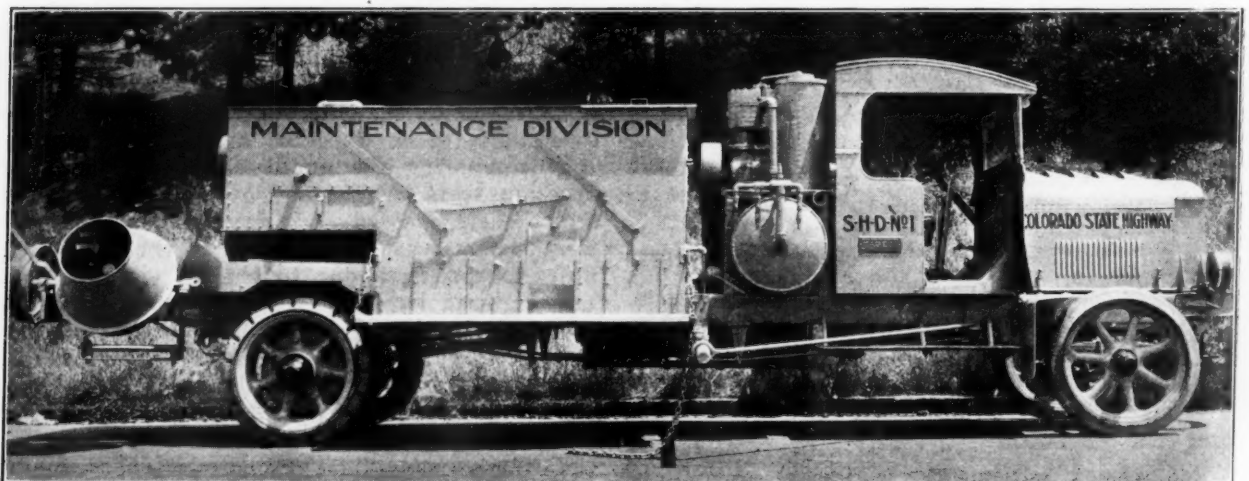
It is also used for erecting or repairing steel, wooden or concrete bridges or culverts, using an oxy-acetylene welding outfit for making steel repairs; a sandblast outfit for removing old paint, rust, etc., and the paint spraying equipment. A rivet heater and riveter is part of the equipment, while the oxy-acetylene outfit is used for cutting out as well as welding damaged metal culverts.

Grading, shouldering-up, rolling or draining right-of-way along highways can be done by use of a grading plow attached to the extension side arm, and by use of the grader and steel roller tire on the rear wheel.

The truck carries steel stencils and uses them in stencilling traffic or ordinance signs by means of the paint spray outfit. A chipping gun is used to chip out cracks in concrete highways and hot tar is injected into them through pressure nozzles. Pneumatic chisels or jackhammers are used for cutting asphalt pavement when excavating for sewer pipes, etc., the excavations being tamped by pneumatic tampers and the surface repaved with asphalt kept hot in the heating tank. High pressure guns with air hose are used for spraying trees and shrubbery; also putting out fires along highways, using for this purpose chemicals carried in a chemical tank. The pump can also be provided with suction hose and used to pump out excavations in bridge or sewer construction.

Record Brick Laying

On September 14th a contest in bricklaying was conducted on a brick pavement being laid between Kansas City and Olathe, between two bricklayers known as "Indian Jim" and Frank Hoffman of Eldorado. Governor Paulen laid a gold brick in the pavement. The contestants started in the center of an unpaved stretch 833 feet long and worked away from each other. Laying was continued from 10 o'clock in the morning until 3:45 in the after-



MAINTENANCE TRUCK OF COLORADO STATE HIGHWAY DEPARTMENT.

noon, with one hour out for lunch. At the end of this time it was found that Hoffman had laid 44,889 bricks and "Indian Jim" 46,644. The latter's average was 114 bricks per minute. He laid four rows at a time and moved no part of his body but his arms, except as he advanced across the street with the progress of the laying. The winner received a cash purse of \$200.

Vehicular Subway in San Francisco

By Charles W. Geiger

The California State Harbor Board has recently completed a vehicular subway at the foot of Market street in front of the ferry building in order to relieve congestion caused by the intersection of street car lines and the motor traffic at this point. Here the heavy industrial traffic bound north and south on the Embarcadero crosses the route of automobiles, taxicabs, delivery trucks and several street car lines, which have the ferry building for an objective or point of departure.

Following the completion of the subway under Market street, more than 8000 vehicles passed through it between 6 A. M. and 6 P. M. on the first day it was opened. The police reported a decided lessening of traffic congestion, and merchants, warehousemen and trucking companies reported a saving of from 45 to 60 minutes each day, or an average of a load and a half more for each truck each working day. Also traffic on the street railway loop in front of the Ferry Building was greatly facilitated and it was possible to maintain a better schedule and better spacing between cars during the rush hours. This is the first subway of this nature that has been built on the Pacific coast.

The total length of the subway is 986 ft. including approaches, each of which is 298 ft. long, giving the roofed section a length of 390 ft. Each end of the roofed section extends 85 ft. beyond the nearest street railway loop to pro-

vide space for pedestrians and automobiles to and from the ferry building. The subway is 23 ft. wide, accommodating trucks moving in single file in both directions, and has a clear height of 13 ft. It is constructed of reinforced concrete, the paved floor being 5 ft. thick and the walls 2½ ft. By means of an automatically operated and electrically driven centrifugal 4-inch pump, which draws from a concrete sump, the floor is kept dry, the water entering the sump through thirty inlets. The pump motor is operated by a float switch in the sump. There are two 8-inch drains in the side walls below the level of the floor, and inlets from the pavement were placed 40 ft. apart in the closed section and 100 ft. apart in the approaches.

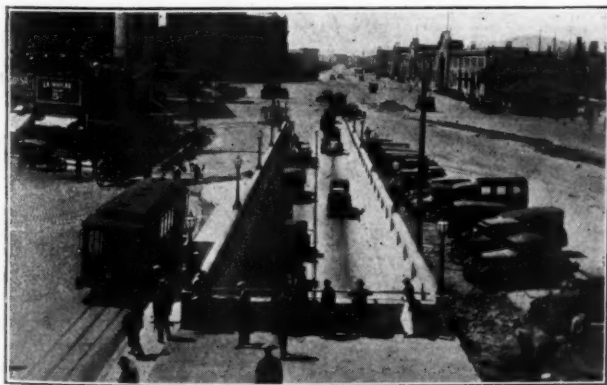
The closed section is lighted by electricity; also by daylight, by means of an 18x23 foot opening in the center of the loop which, like the approach sections, is enclosed by panelled parapet walls.

This subway was constructed at the site of a heavy timber platform 12 ft. below street level which had been constructed about 1889, in connection with the building of a new sea wall and filling in the space behind it. Most of the old piling which supported the platform was found to be perfectly sound and was used for the foundation of the subway.

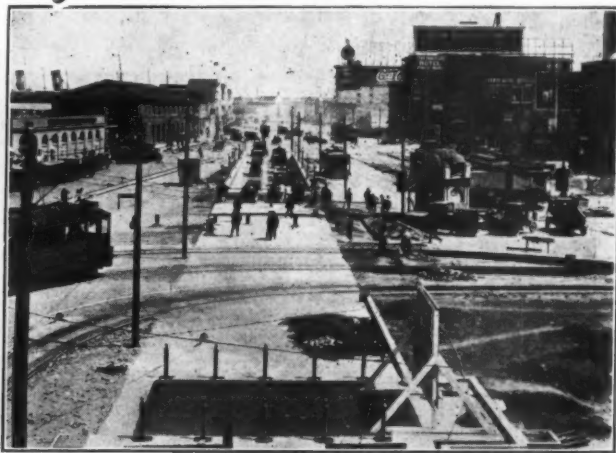
Frank G. White, the chief engineer of the Board of State Harbor Commissioners, was engineer of this work.

Duty of Waltham Pump

In the report for 1924 of the Water Division of the City of Waltham, Mass., are given figures which indicate an unusually good station efficiency recorded for the Barr pump operating in Station No. 1. The pump was operated 364 days in the year, approximately six hours a day, being banked 18 hours a day. The duty of the pump based on the total fuel consumed and the total pumpage without allowance for slip is calculated at 100,993,000 gallons. New River bituminous coal was used with 10.48 per cent ash. The pump operated against an average static head of 202.6 feet or an average dynamic head of 230.7 feet.



LOOKING SOUTH FROM THE OVERHEAD PEDESTRIAN BRIDGE TO FERRY BUILDING. SHOWING THROUGH TRACKS ON THE FERRY LOOP.



LOOKING NORTH FROM THE OVERHEAD PEDESTRIAN BRIDGE TO FERRY BUILDING.

Denver's Concrete Sand Trap

Installed in bottom of canal, with provision for sluicing sand back into river.

By Ivan E. Houk

The accompanying photographs show a concrete sand trap of rather unusual design, built on the Denver Water Company's High Line Canal about twenty miles southwest of Denver, Colorado. The trap is simply a concrete box set transversely in the bottom of the canal and provided with gates at one end so that the sand, which settles in the box, can be sluiced back to the river. The trap is located about a mile below the High Line Canal intake on the South Platte river, and about a quarter of a mile above the three-hundred-million-gallon Platte Canyon

reservoir, which stores water for the Denver municipal supply and which is filled from the High Line Canal. Thus the sand is removed from the canal flow before it enters the reservoir.

The trap is $2\frac{1}{2}$ feet deep and 18 feet wide, and extends entirely across the bottom of the canal. It is built so that the top of the box is flush with the canal bottom. The upstream side is built on a slope, instead of vertical, so that the water and sand can flow into the trap more easily. The top is covered with plank from the downstream edge to the angle iron about $4\frac{1}{2}$ feet from the upstream edge, as shown at the left of one of the views, thus leaving a comparatively narrow slit for the water to enter the trap. Concrete training walls guide the water from the entrance slit to the two 4x5-foot sluice gates. Consequently the water drawn out must come from the bottom of the flow section where the greater part of the sand load is carried.

The High Line Canal, an old irrigation canal now controlled and operated by the Denver Board of Water Commissioners, is about 54 feet wide, about 6 feet deep, and normally carries a flow of about six hundred cubic feet per second. Considerable trouble has been experienced with sand accumulations, since the flow of the South Platte river often carries heavy loads of sand and since these loads cannot be removed at the intake. Before the sand trap was built it was necessary to clean the canal about once a year. Now, by setting the gates approximately three or four inches open, and discharging about fifty second feet



SAND TRAP, SHOWING TRAINING WALLS AND SLUICE GATES.



SHOWING LOCATION OF SAND TRAP ACROSS CANAL BOTTOM.

of water, nearly all of the sand accumulations can be sluiced back to the river in a few minutes time.

The sand trap was built by city forces under the supervision of A. D. Rowell, superintendent, during January and February, 1925, at a total cost of \$7,500, including gates and tail race. The foregoing information was furnished by D. D. Gross, office engineer, and T. J. Leahy, assistant engineer in charge of work. Burton Lowther is chief engineer for the Board of Water Commissioners.

Large Florida Paving Contract

As an item in the phenomenal development of Miami and the neighboring country, a \$2,000,000 contract has recently been let for street construction at Coral Gables by Geo. B. Merrick to W. T. Price, of Miami, as contractor, who expects to complete the work this winter. The contract includes both sidewalks and roadways. The streets will be 60 to 100 feet wide, and will connect with those to the north laid three years ago, and connect the Biscayne Bay waterfront with the Tamiami trail.

Normalcy in Chemical Treatment of Sewage

Tendency toward use of it as supplementary to biological processes in treatment of both sewage and sludge. No longer being installed as sole or main treatment. Experiments with use of acids, saltpetre and other agents.

By J. Frederick Jackson

In considering the progress which has been made in disposal of sewage, one is impressed with the confusion of opinion as to use of chemicals in its treatment.

Chemical treatment began to decline with recognition of the effectiveness of biological processes, though, as the development of these methods progressed, it was found that they were not entirely successful with all kinds of sewages. Nevertheless, in this country there have been no installations of any magnitude in the last twenty years, and in England, where it had been very popular, its use has been decreasing. One of the leading technical journals in this country, commenting on a review by a foremost engineer, of sewage treatment in England, and in particular, his statement that no chemicals were being used at any of the plants because the cost was not warranted by the results, states that it holds no hope for the future. At the same time a prominent English journal speaking of recent experiments in connection with an activated sludge plant said that without the use of chemicals satisfactory results could not be obtained. Worcester, which had one of the largest and most complete chemical precipitation and sludge pressing plants in this country, is preparing to abandon it, and has about completed a new plant of Imhoff tanks and sprinkling filters. In contrast to this at the new activated sludge plant in Milwaukee they are preparing to press the sludge in vacuum filters after first conditioning it with acid.

These apparent contradictions among the leaders of public opinion retard the satisfactory solution of the whole problem of sewage disposal and it is time that the question was definitely decided.

Recently there has been a tendency to recognize the value of the use of chemicals preliminary

or supplementary to other treatments, particularly in treating wastes on which biological processes have no effect. A review of the literature shows the present trend of opinion.

Phelps found that the chemical composition of the sewage had an important influence on the germicidal value of disinfectants, that there was advantage in the use of those which were entirely used up or converted into harmless compounds.

Hatton states that when, in the conditioning of sludge at Milwaukee, its normal temperature was raised to 120 to 180 F., and its pH value kept between 3.3 and 4 by sulphuric acid, 65 lbs. per 24 hrs. per sq. ft. of filter cloth was produced, the moisture was reduced from 99 to 80% and the bacteria in the filtrate were reduced to 100 per c.c.

Fuller states that the selective action of bacteria causing temperatures of 60 to 80 degrees F., convert sewage into an effective coagulant.

Wilson, Copeland and Heisig found that the best temperature lay between 11° and 34° C.; that 0.1% of aluminum sulphate reduced the time of filtering sludge, and concluded that the temperature at which best results would be obtained indicates that they were due to bacteria, not to enzymes.

In the model plants at Huddersfield, England, experiments without chemical treatment did not give satisfactory results with either raw sewage or the effluent. When chemicals were used good results were obtained. At Bury, England, prolonged sedimentation before aeration was found to be necessary in treating sewage containing trade wastes.

Mohlman and Pearse, at Chicago, found alkaline chemical precipitation effective in removing colloidal matter but productive of excessive amounts of sludge; acid treatment, by neutralizing electric charge and causing coagulation, might be effective.

*Consulting engineer, New Haven, Conn.

in treating packing house wastes; with acid the oxygen required was reduced 40%; with Imhoff tanks the reduction was 23 to 32%.

Richards and Sawyer at Rothamsted found that if activated sludge is aerated for a short period in an ammoniacal solution, the recovery of nitrogen is quantitative. The nitrogen not found in the effluent as ammonia or nitrate is recovered in the sludge. The same effects were noticed with sewage. The reaction from these results suggest that chemical treatment of sewage per se is growing less, while chemical treatment of sludge is in its ascendancy. They also suggest that constituents other than alkalinity and acidity are effective. Change in temperature has a noticeable effect. While it has been demonstrated that the presence of iron salts in the sewage has a marked effect on the activated sludge process, research work along this line has not explained the effect of their presence sufficiently to allow the engineer to apply the results in a practical manner to the treatment of sewages of different composition.

In the work of investigating pollution of the streams in Connecticut, experimental stations were maintained at New Britain and South Manchester and different chemical and biological processes were tried out in treating those two sewages.

EXPERIMENTAL WORK AT NEW BRITAIN

The sewage at New Britain is a fairly strong domestic sewage containing at times large quantities of oil and grease, considerable iron, some weak dye wastes, and fleshings and hair from slaughter houses.

The following analysis shows a sewage of about average strength, the only constituents which might affect successful application of biological methods being the dissolved solids and iron salts.

Analysis of Sewage at New Britain		
Organic nitrogen	12.9	p.p.m.
Free ammonia	13.2	"
Nitrites .....	.25	"
Nitrates	1.93	"
Oxygen consumed	43	"
Total solids	489	"
Total volatile solids	234	"
Total suspended solids	129	"
Total volatile sus. solids	93	"
Chlorides	40	"
Alkalinity	118	"
Iron	9.2	"
Dissolved oxygen	22.0%	saturation
Bacteria	319,000	per c.c.
Temperature	14	Deg. C.

With the sewage at New Britain, fine screening, plain sedimentation, trickling filters, Miles acid and activated sludge processes were tried; also special experiments with lime and acid in treating sewage, and acid and heat in treating sludge.

The results which we wish to discuss are the effects of chemical treatments, either used alone or in combination with biological processes, on the sewage itself, and on sewage sludges. The object sought was the production of a non-putrescible effluent with minimum of nuisance and inconvenience, and at minimum cost.

ACID AND AERATION WITH ACTIVATED SLUDGE

Certain inconsistencies were noticed in the Miles acid process, such as the solvent action on the organic matter and suspended solids, the low

removal of organic matter accompanied by the high removal of suspended matter. This suggested further treatment by neutralizing the effluent and treating it with activated sludge. Accordingly 500 gallons of Miles acid effluent corresponding to raw sewage of 7.00 a.m. was aerated with 1,300 cu. ft. of air; 1.1 pounds of lime was then added, and 150 gallons of this sewage was replaced by an equal amount of activated sludge having a concentration after mixing of 16% after ½ hour settling. This was then aerated for 60 minutes. After each step samples were collected in two-gallon bottles where they were permitted to settle for one hour before analyzing them. The results are shown in the following table:

ACID AND AERATION WITH ACTIVATED SLUDGE

Chemical Treatment		Effluent Neutralization Following 60 Min. Aeration After Miles Acid Treatment
Effluent, Miles Acid Treatment	Percent Removal Effluent, 60 Min. Aeration Following Miles Acid Treatment	
Org. Nit.	2.0	26.0
Nit. as Free Amm...	34.3	31.4
Nit. as Nitrites	100.0	100.0
Nit. as Nitrates.....	-388.*	-589.*
Ox. Cons.	-17.1*	5.7
Tot. Sus. Solids	70.0	7.0
Vol. Sus. Solids.....	...	28.6
Chlorine	0.	-5.9*
Alkalinity	320.6	76.5
Iron	-400.*	-329.*

*Increase.

Biological Following Chemical Treatment		Removal Effluent 60 Min. Activated Sludge Treatment Following Neutralization, Etc.
Effluent South Manchester Activated Sludge Treatment Following Neutralization, Etc.	Percent	
Org. Nit.	60.0	44.0
Nit. as Free Amm.....	0.	-2.9*
Nit. as Nitrites	54.5	80.0
Nitrogen as Nitrates.....	-545.*	-233.*
Ox. Cons.	34.3	22.9
Tot. Sus. Solids	86.4	81.4
Vol. Sus. Solids.....	...	...
Chlorine	0.	-5.9*
Alkalinity	76.5	76.5
Iron	100.0	4.0
Relative Stability.....	52.	88.

*Increase.

DISCUSSION OF EXPERIMENTAL DATA

Aeration of the Miles acid effluent alone gave but slight decrease in the organic matter. Upon adding lime, there was a further decrease in organic nitrogen and oxygen consumed. The free ammonia increased as did naturally the suspended solids, the iron remaining unchanged. Introducing the activated sludge and aerating for 30 minutes caused a marked decrease in organic nitrogen, oxygen consumed and suspended solids. The iron was entirely removed but the free ammonia showed a still greater increase. Stability was fairly high. Increasing the aeration period with activated sludge did not cause any improvement except greater stability which was very noticeable.

SALTPETRE

The rather disappointing results obtained from reaeration of sludge led us to try an experiment with saltpetre to see if in this way we could not increase the supply of available oxygen. Accordingly about 350 gallons of sewage and 110 gallons of sludge, the consistency of the mixture being 15%,

were treated with NaNO_3 using from 14 to 100 p.p.m. and aerating from $\frac{1}{2}$ to 3 hours. 1 to 16 cu. ft. of air per gallon of sewage was used.

Analysis after Treatment with Saltpetre

	Raw	Effluent	% Removal
Org. Nit.	13.2	9.3	29.5
Free Amm.	19.3	17.0	11.9
Nitrites ....	.2	1.2	...
Nitrates	1.4	3.3	...
Iron	5.5	1.6	...
Relative Stability ....	...	88.	...

Good clarification was obtained as well as high stabilities and almost complete removal of iron. The removals of organic matter were, however, less than in the straight activated process. Reaeration of the sludge did not give any better removals of organic matter.

LIME

Five hundred gallons of sewage was then taken, dosed with lime at a rate of 1,500 pounds to the million gallons, aerated from 3 to 10 minutes and allowed to settle from $\frac{3}{4}$ to 1 hour.

A very fair removal of organic and suspended matter was obtained and high removal of the iron. Increased aeration and settling periods would have given better clarification and produced a much more concentrated sludge.

Comparing these two experiments with the results from straight activation, when it was aerated from 3 to 4 hours, settled from 45 to 60 minutes and 0.9 to 1.5 cu. ft. of air per gallon was used, the improvement was not as good in either case.

Limed and Activated

	Raw	Effluent	% Removal
Org. Nit.	18.8	10.3	45.1
Free Amm.	26.2	19.2	27.0
Nitrites	0.	0.4	...
Nitrates ....	.15	.45	...
Ox. Cons.	49.	24.	51.0
Total Solids ....	...	...	...
Vol. Solids ....	...	...	...
Tot. Sus. Sol.	169.	77.	54.5
Vol Sus. Sol.	109.	37.	66.0
Chlorine ....	...	...	...
Alkalinity	181.	266.	...
Iron	4.6	0.5	89.0
Per Cent Saturation....	...	...	...
Relative Stability ....	...	...	...

Straight Activation

	Raw	Effluent	% Removal
Org. Nit.	13.0	4.1	68.5
Free Amm.	12.6	11.4	9.5
Nitrites ....	.23	.55	...
Nitrates	1.9	2.7	...
Ox. Cons.	43.0	13.4	68.9
Total Solids ....	...	...	...
Vol. Solids ....	...	...	...
Total Sus. Sol.	121.	20.	83.5
Vol. Sus. Sol.	87.	15.	82.8
Alkalinity	115.	103.	...
Iron	8.8	1.7	80.8
Per Cent Saturation....	26.	63.	...
Relative Stability ....	...	89.	...

ACID PLUS HEAT

In the experiments on dewatering sludge by addition of acid and applying heat, a unit consisting of a reaction chamber and heating coil was installed in the small tank used for reaeration of sludge.

The settling of the tank interfered with proper control of the water level and its depth, six feet, was not sufficient to give best results.

The sludge was drawn off at a uniform rate

through the orifice box into a funnel at the top of the inlet pipe and about a two per cent solution of sulphuric acid added to it. Mixing of acid and sludge took place in the inlet pipe and reaction chamber, the mixture of sludge and acid flowed up past the heating coil causing the sludge to contract and float to the top of the tank, where it overflowed into the discharge launder. During the experiments the activated sludge plant was operating at a rate of 70,000 gallons per day with a retention period of 2.4 hours, a 36 minute settling period, and using 1.1 cubic feet of air per gallon of sewage.

At these rates not enough sludge was being built up to keep the flotation unit operating efficiently at all times.

Using this water jacket, the best results were obtained with a temperature of 50 degrees C. Heating directly with the coil reduced this to 30 degrees C. and good results were had even at 27 degrees C.

Treatment with Acid and Heat

	Influent	Effluent	% Removal
Org. Nit.	293.	73.	75.0
Free Amm.	50.	12.5	75.0
Ox. Cons. ....	...	144.	...
Total Sus. Sol.	4,640.	989.	79.5
Alkalinity	237.	-177.	...

The moisture content of the sludge was reduced from 99.55% to 88.2% and still greater reductions could have been obtained with a deeper tank and better control of the heat.

Suspended solids in the effluent ran as low as 55 p.p.m. and turbidity to 30 p.p.m. The suspended solids average about 3 times the turbidities and about 76% were recovered in the sludge. This figure corresponds exactly with the nitrogen recovered from the sludge, which would indicate that with this process practically all the nitrogen is in the suspended matter and can be recovered.

With the activated sludge process, the presence of iron in the sewage seemed to have the most effect on the relative stability and the volume of air required. In the flotation process there was marked agreement between removals of suspended matter and iron which would indicate that the iron found in the effluent comes from the suspended matter and is not dissolved out by the acid from the influent sludge. This would appear to be confirmed by the fact that the reaction of the floated sludge was always alkaline.

A noticeable feature of the process was the misleading appearance of the effluent. When flowing it seemed to be quite clear; actually the turbidity ranged from 20 to 150 p.p.m.

The process seems to change the structure of the sludge from a colloidal to a granular nature.

SUMMARY

Summarizing the results of these experiments, acid treatment of the New Britain sewage by itself gave a fairly good removal of suspended, settleable solids and bacteria. There was only slight oxidation of the organic matter and very little effect on the iron. Neutralizing the effluent and aerating it in the presence of activated sludge gave high removals of all constituents except free ammonia, and increased the stabilities materially. The effect of saltpetre was to increase clarification stability and removal of iron. Using lime and aerating, the re-

movals were all fairly high, depending on the length of the aeration and settling periods. None of them gave as good results as the straight biological processes. Their use as a preliminary treatment to accelerate reactions appeared promising. Whether it would decrease operating costs materially could only be determined from experimentation on a much larger scale. The most conclusive results were obtained from the experiments on the activated sludge with acid and heat. These demonstrated clearly that with a properly designed and well operated unit, large decrease in moisture content and high removal of nitrogenous and suspended matter could be obtained.

(To be concluded)

Percolating Bacteria Beds

Result of experiences with plant at Leeds, England, using different kinds of medium and of distributors, and side and bottom aeration.

The experience of Leeds, England, during several years past with experimental and full-sized sprinkling filters was reviewed by John T. Thompson in a paper presented at the annual summer conference of the Association of Managers of Sewage Disposal Works. The following abstract of the paper was prepared for the Bureau of the Public Health Service by J. K. Hoskins:

Nature of Medium. Tests of durability of different kinds of mediums were made in an experimental bed 6 feet deep and divided into six sections, each 12 sq. ft. in area, tank effluent being distributed on each section by a single jet. After some years, 2 tons of material were removed from the center of the beds 3 ft below the surface and examined. The results were as follows:

Medium	Weight per cu. yd. cwt.	Size at start inches	Dura- tion through test years	Per cent passing through 1-in. sieve at end
Gravel	25	1 —2¼	4.5	3
Dolomitic limestone....	23	1 —2½	4.5	7
Honeycomb blast furnace slag	11.5	1 —2½	2.	15.7
Siemens Martin slag..	29	1 —2¼	3.	2.8
Gas coke	14	1½—3	8.	55.*

Kind of medium had no effect on quality of effluent except that the gravel sections were more liable to ponding. Gravel beds have been in use for 20 and 25 years at Leeds without washing or renewal being required.

Size of medium is important and must be large enough to provide air spaces between the surface films, allow passage of undigested solids and overcome clogging from fungoid growths. Leeds uses 1-in. to 3-in. filling for the beds, which will treat a tank effluent containing up to 100 p.p.m. suspended solids. Methods of determining the time of contact

*Through 1½-in. sieve.

in beds 6-ft. deep by means of salt solution are discussed, from which the following average results were obtained when the flow was kept constant at 200 gallons per cu. yd. per day.

TIME OF CONTACT IN FINE AND COARSE MEDIA

	Mean time of contact hrs.	Total liquid content per cu. yd.
New fine medium (¼-in. to 1-in.)...	1.4	11.3 gals.
Matured medium (¼-in. to 1-in.)...	2.5	20.8 "
New coarse medium (1-in. to 3-in.)...	1.0	8.3 "
Matured medium (1-in. to 3-in.)....	1.7	14.1 "

These results indicate that the maturing of the bed increases the mean time of contact by 70-80 per cent.

Aeration of Bed. Side aeration is not only unnecessary but may be injurious especially in cold weather when temperatures are lowest. Bottom aeration is provided by tiles properly sloped to prevent clogging.

Distribution of Influent on Beds. Tests of various kinds of distributors indicated that the traveling types afforded more uniform distribution than fixed jets. The use of small holes on any type of distributor results in clogging, better results being obtained by discharging the liquid through a hole about one inch in diameter against a dashplate or allowing it to flow over a sill. Detailed results presented indicate that "where the liquid is distributed fairly continuously by fixed jets or rotary sprinklers, surface growth can be controlled by giving a suitable rest period each day and distributing at a proportionately higher rate for the remainder of the 24 hours. It was found possible to treat at least 10 per cent. more tank effluent in a year by dosing at the rate of 300 gals. per sq. yd. per 24 hours for 16 hours and resting 8 hours, than by running continuously at 200 gallons per sq. yd. per 24 hours, owing to time lost in stoppages to get rid of ponding." No appreciable difference in effluent by the two methods was obtained.

Description of Leeds Plant. The method of treatment at Leeds, consisting of chemical precipitation with ferric sulphate and passing the effluent through sprinkling filters, is discussed in detail, giving operating results. Fly nuisance in the percolating beds has been continuous and none of the control methods so far tried have been successful, although work is being continued.

Climate and Road Work

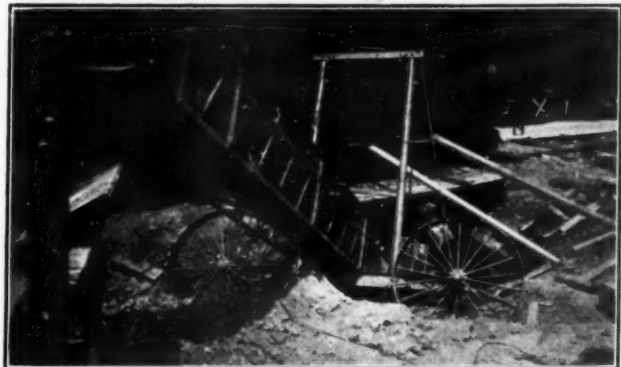
Notes from New Mexico highway patrols for July incidentally give interesting information concerning the effect of climate upon road work, especially humidity and rain. For instance, in reporting for that month Patrol Number 11 stated: "Until the recent rains it was necessary to haul water in tanks to sprinkle and flood the road in order to make any progress at all, but now that we have a good downpour, we expect to make some marked improvements over the entire patrol." During the month there was a heavy rainfall which not only made unnecessary the hauling of water, but came in such quantities as to do considerable damage to roads and culverts. Not only this, but Patrol Number 2 reported: "After the flood it was some time before we could even get out equipment, as the roads

were so bad that the machinery would only have mired in the mud."

Handling Slag for East Sparta Sludge Beds

Eighty thousand cubic yards distributed to beds 880 feet long by a series of four belt conveyors, taking from six steel track hoppers.

Reconstruction of the City of Canton's sewage disposal plant at East Sparta, Ohio, is being carried on by the Holmes Construction Company. About 80,000 cubic yards of slag were removed from the filter beds, the beds were then rebuilt, and now are



BELT CONVEYOR REMOVING SLAG FROM TRACK HOPPER



INTERMEDIATE CONVEYOR DELIVERING TO FINAL CONVEYOR

being refilled with fresh slag. The most interesting feature of this work is the method employed in handling the slag.

The old slag, which of course was highly polluted, was loaded into trucks by two clam-shells and one Barber-Greene self-feeding bucket loader, the daily output of the clam-shells being 600 cubic yards and that of the bucket loader 400 cubic yards.

For handling the new material, a unique system of

portable belt conveyors has been provided by the Barber-Greene Company. Slag (furnished by the Standard Slag Company of Cleveland) is received in railroad cars, and is dumped from the cars into a small steel track hopper which feeds onto a short portable belt conveyor. The belt is 18 inches wide by 30 feet long and is provided with steel cross cleats which enable the machine to carry the slag easily up from the pit to discharge onto the next conveyor.

The conveyor in the pit is mounted on wheels, so that it can be moved from one track pit to another as the filter beds are filled with their quota of slag.

The second conveyor is a shuttle with an 18 in. x 60 ft. belt. The machine is mounted on four extended legs which carry axles and single flanged wheels which run on standard 30 in. gage industrial track. With this shuttle mounting it is possible to deliver the slag 60 ft. or more in either direction from a track pit. This obviates the necessity for many track pits, which is quite a consideration since the filter beds are 880 ft. long. With the use of the shuttle, the track pits are placed 150 ft. apart, and there are only six of them all told. Of course, the belt on the shuttle conveyor can be run in either direction; it is electrically driven.

From the shuttle, the slag is delivered to an 18 in. x 111 ft. belt mounted on special trucks so that it can be moved at right angles to its length. The trucks are made with four wheels to run on 30 in. gage track. Since this conveyor much of the time is being supported on the newly laid slag, the trucks are flexibly attached to the conveyor support, thus allowing considerable variation for irregularities in the track. In order to reach the filter beds farthest from the railroad track—the whole basin being 440 ft. wide—it will be necessary to extend the reach of the conveyor system by means of another belt similar to this 111 ft. machine. This machine will be 220 ft. long.

A tractor crawler chassis, taken from a Model 42 bucket loader, carries the last conveyor, an 18 in. x 81 ft. machine. The connection



FINAL CONVEYOR DISCHARGING ONTO BED THROUGH A SWIVEL CHUTE

between the chassis and the conveyor is such that the crawler unit can turn about freely under the conveyor. While the stone is being discharged into the filter bed from the belt of this machine, the chassis is moved to "fan" the conveyor about its hopper as a pivot. Further flexibility is obtained in this machine by the use of a swivel discharge chute 15 ft. long.

A car of slag is easily unloaded and deposited in the filter beds over the conveyors, using only three to five men, in 40 minutes. Ten to twelve cars a day are handled easily.

When moving from one setup to another, the crawler chassis is turned at right angles to its "fanning" position and either pushes or pulls the hopper end along the slag fill to the new position.

All of the conveyors are driven with electric motors suitable for their size. The crawler chassis is driven by a Buda gasoline engine. When this job is completed, the Holmes Construction Company plan to take this chassis, add the necessary boom and feeder, and thus have a standard self-feeding bucket loader which they can use on their road work.

Zoned Municipalities

According to the Division of Building and Housing of the Department of Commerce, there has been an increase of more than 130% in the number of people living in zoned cities and towns in the United States during the past four years. By the first of July, 1925, more than 26 million people were living in 366 zoned municipalities, as against less than 11 million in 48 municipalities in September, 1921. Twenty-seven of the 33 largest cities in the United States having populations of over 200,000 have now adopted zone ordinances. During the first six months of this year, zoning legislation was enacted by Arizona, Idaho, Maine, New Hampshire and Utah, four of these using the Department of Commerce Standard Act wholly, or in large part, in drafting their laws.

Snow Removal and Equipment

At the fourth annual meeting of the Highway Research Board, Sub-Committee No. 3 on Snow Removal and Snow Removal Equipment submitted a report, presented by W. A. Van Duzer, deputy engineering executive, Pennsylvania Department of Highways, giving some figures and conclusions obtained by a questionnaire sent to the various state highway departments. This questionnaire asked for the number of miles in the highway system, mileage from which snow was removed in 1923-24, whether removed the full width of the pavement, amount of snow fences, number of snow plows, and average cost per mile of snow handling.

In mileage of snow removal, Missouri led with 7,640 miles, the total mileage of the system; but

as there is comparatively little snow fall in the state and the cost per mile was given as \$5, this state is hardly entitled to first place. Iowa also reports snow removal from its entire mileage of 6,647 miles, but as the average cost was only \$20 and it reported only 12 snow plows, it apparently must yield first place to Pennsylvania which carried out a snow removal program on 4,000 miles of its 10,770 at an average cost of \$75 per mile and with the use of 389 snow plows.

Virginia, although a southern state, reported the use of 260 snow plows, keeping clear its entire system of 4,500 miles. In number of plows, Connecticut comes next with 232 plows used on 1,800 miles of road, the cost of snow removal having averaged \$30.35 per mile. Massachusetts reported 197 snow plows used at 1,000 miles of road and an expenditure of \$79.55 per mile. New Jersey used 150 snow plows on 745 miles with an average expenditure of \$203.31 per mile. North Carolina used 100 snow plows on 3,872 miles of highway, spending an average of \$10 per mile.

Considering the states with reference to expenditures per mile, Nevada leads with \$400, New Jersey is second with \$203.31, Wisconsin third with \$200 and Washington next with \$145. Few of the southern states reported any expenditure for snow removal and nothing was reported by Montana, New Hampshire, New York, North Dakota, Vermont and Wyoming among the northern states. In some of these northern states, if not all, more or less snow removal was performed by counties or other political units.

Some of the states placed considerable reliance on snow fences, but the majority of them had not set any such fences prior to the winter of 1923-24 to which this report applied. The mileages of snow fences reported were as follows: Colorado 5, Connecticut 5, Iowa 60, Maryland 10, Massachusetts 3, Minnesota 95, Nebraska 14, Nevada 2, Oregon 7, Pennsylvania 75, South Dakota 2, Utah 10, Wisconsin 100 and Wyoming 5.

Discussing the subject of equipment, the report states that the type which is believed to be most suitable for coping with heavy drifts and long stretches of heavy accumulations is the tractor pushing a V plow with spreader wings. "A more effective type of machine for heavy work is the rotary plow which removes the snow to a sufficient distance so that subsequent drifting is not increasingly cumulative. This type of equipment, however, is a great deal more costly and I believe its maintenance and depreciation would be heavier and that the purchase of equipment of this character would not be justified except in particular localities where extremely heavy snow and traffic conditions warrant the increased expenditure.

"Snow removal equipment is in actual use for only a few days in the year and conversely is in storage and idle during the greater part of the time. Therefore in considering the problem of snow removal, we are forcibly confronted by the necessity of rigid economy in purchasing. So far as possible, I believe that the general rule should be to use for snow removal such maintenance and construction equipment as is already on hand."

Recent Legal Decisions

RESTRICTING STORAGE OF EXPLOSIVES IN RESIDENTIAL DISTRICTS

The West Virginia Supreme Court of Appeals holds, *State v. Stark*, 122 S. E. 533, that an ordinance of the city of Charleston, prohibiting, within city territory immediately bordering the state capitol grounds and closely built up with valuable residences, the storage of gasoline, naphtha, kerosene, gunpowder, dynamite and like explosive materials, should be upheld as a reasonable exercise of the police power of the municipality.

CONTRACTOR NOT LIABLE FOR UNWITTING TRESPASS DIRECTED BY CITY

A bridge contractor's contract with a city provided that the city should procure the necessary right of way for the bridge and approach. The contractor entered upon private property and constructed the approach thereon by direction of the city's engineer in charge of the work, not knowing that the city had no right there. The Iowa Supreme Court holds, *Horrabin v. City of Des Moines*, 199 N. W. 988, that the case formed an exception to the general rule that there can be no contribution or indemnity between joint tortfeasors, since the contractor has a right to assume that the city had acquired the right to use the ground, and that, a judgment having been recovered against both the city and the contractor for the damage resulting from the trespass, which the contractor paid, he was entitled to recover the amount thereof from the city notwithstanding provisions in the contract that the contractor should indemnify the city for damage to property arising from any act done or suffered to be done by him and pay all just claims growing out of the work from trespass on his part.

SUFFICIENCY OF IMPROVEMENT ORDINANCE

An ordinance provided for the improvement of a specified street "to the overgrade railroad crossing." Two structures over different tracks answered that description. The Pennsylvania Supreme Court held, *Rochester Borough v. Pittsburgh, Ft. W. & C. Ry. Co.*, 123 Atl. 319, that evidence, largely parol, was admissible to show that one of them was, and the other was not, generally known in the borough as "the overgrade railroad crossing."

UNREMUNERATIVE EXTENSION OF WATER MAINS REFUSED

The Maine Supreme Judicial Court holds, *Public Utilities Commission v. City of Lewiston Water Co.*, 123 Atl. 177, that it will not review an order of the Public Utilities Commission requiring a growing and populous city to extend its water mains to a partially developed and sparsely occupied locality, made after two hearings, where the disproportion of revenue to cost is not so fixedly great as to make the order confiscatory.

CITY NOT LIABLE FOR FIRE DAMAGE CAUSED BY UNREPAIRED STREET AND FAULTY HOSE

The Kentucky Court of Appeals holds, *Sewall v. Board of Council of City of Frankfort*, 261 S. W. 1111, that a municipality is not liable in damages for the destruction of a citizen's property by fire because it allowed the street leading to the property to be in such bad repair that the fire engine could not travel it and failed to provide sufficient hose to reach from the nearest water hydrant to the property, a distance of about 1,000 feet.

PROHIBITORY ORDINANCES AS TO TRAINING AND KEEPING ANIMALS HELD INVALID

The Texas Court of Criminal Appeals holds, *ex parte Harris*, 261 S. W. 1050, that a city has no power, in the absence of specific statutory authority, to prohibit by criminal ordinance an occupation which is not a nuisance in fact, and an ordinance of the city of Austin making it unlawful for any person to cure green hides or poison dry hides within the city limits was held to be not regulatory, but prohibitory and unenforceable. The vocation of tanning hides was held to be not a nuisance per se, but of such a nature that it might become a nuisance according to the manner or place of its pursuit, and therefore a subject for reasonable regulation, which, however, the ordinance did not attempt.

The same court holds, *ex parte Koenneritz*, 261 S. W. 570, an ordinance which makes the keeping of animals which make such sounds as "disturb the inhabitants" of the vicinity a nuisance is too indefinite to accomplish the purpose intended and therefore invalid.

MUNICIPALITY HELD NOT LIABLE FOR NEGLIGENT CONDITION OF WATER SYSTEM IN PARK

The Georgia Court of Appeals holds, *Antry v. City of Augusta*, 127 S. E. 796, that a municipality, in the maintenance of a park intended primarily for the use and benefit of the public at large, is not liable for a negligent condition of a part of its water system located in the park and devoted solely to the control of the flow of water into a pool forming a part of the park, and used only for the general purpose thereof in the promotion of the pleasure and health of the citizens, although the city's general water system may be operated for gain.

LIABILITY FOR NEGLIGENCE IN MANAGEMENT OF STREETS HELD NOT EXTENDED TO PUBLIC PARKS

The Utah Supreme Court, *Alder v. Salt Lake City*, 231 Pac. 1102, is of opinion, with the great weight of authority on the question, that the maintenance of parks and playgrounds is a public and governmental function, and that the municipality is not liable for the negligence of its agents and servants in connection therewith. The exception to the general rule of immunity in the case of streets, the court says, is founded on public policy and expediency and is recog-

nized in Utah by statute. It adds that "the nature and use of streets are quite dissimilar from the nature and use of parks and playgrounds, and the reasons for which liability is imposed in the case of the former are not applicable to the latter."

It was held that the defendant city was not liable to the witness of a pageant presented by the city in a public park on 4th of July through the collapse of seats.

UNAUTHORIZED CLAIMS AGAINST MUNICIPALITIES— POWER TO CONTRACT

The Oklahoma Supreme Court holds, *City of Tulsa v. Malloy*, 231 Pac. 256, that one who demands payment of a claim against a municipality operating under a charter form of government must show some provision of such charter authorizing it, or that it arises from some contract, express or implied, which finds authority in the general statutes of the state, and it is not sufficient that the performance of the contract for which payment is claimed is beneficial.

Whoever, it is held, deals with a municipality does so with notice of the limitations on its or its agent's powers. All are presumed to know the law, and those who contract with it or furnish it supplies do so with reference to the law, and, if they go beyond the limitations imposed, they do so at their peril. A contract in its origin not obligatory upon the municipality, because not made in the mode prescribed by the charter, cannot be affirmed and ratified in disregard of that made by any subsequent action of the municipal authorities, and a liability be thereupon fastened upon the municipality. The case concerned supplies alleged to have been made to various of the city departments.

NOTICE OF PROPOSED PUBLIC IMPROVEMENT HELD INVALID

The New Jersey Court of Errors and Appeals holds, *Burnstiner v. East Orange*, that a notice of the intention of a municipality to consider the undertaking of a public improvement, prescribed by section 9 of article 20 of the Act Concerning Municipalities, as amended (P. L. 1918, p. 484), which, when any part of the cost thereof is to be assessed upon lands benefited thereby, does not specifically refer to the said improvement as "local" or in some other way make it clear that such cost is to be so assessed, is fatally defective.

MUNICIPALITY'S JURISDICTION OVER STREETS IM- PROVED BY COUNTY

The Georgia Supreme Court holds, *Wood v. Shore*, 127 S. E. 145, that when a municipal corporation is created it becomes vested with jurisdiction over the territory embraced within its corporate limits, and the mere fact that there has been a valuable improvement made by the county authorities on one of the streets of an incorporated city does not oust the municipality of its jurisdiction over such street. This is true notwithstanding the street improved was, before the incorporation of the city, a part of an established public road of the county.

MUNICIPAL ORDINANCE REGULATING TAXICAB STANDS HELD VALID

The West Virginia Supreme Court of Appeals holds, *Henderson v. City of Bluefield*, 127 S. E. 492, that a municipal ordinance making it unlawful for drivers or proprietors of taxicabs, motorbusses and jitneys to solicit passengers for hire on the streets of the municipality, to stand or park them in the city closer than 100 feet of any railroad passenger station or the terminus of any interurban street railway car line, or to leave such vehicles during the time they are being used in the public service, and providing penalties therefor, should be upheld as having been enacted in the reasonable exercise of the police power of the municipality, and its charter authority to pass ordinances for the regulation of automobiles and other vehicles within the municipality promotive of the interest or convenience of the inhabitants thereof.

UNAUTHORIZED AGREEMENT TO MAINTAIN BRIDGE AS COMPENSATION FOR LAND APPROPRIATED BY CITY

The Kansas Supreme Court, *Mathewson v. McLean*, 232 Pac. 233, holds that a city undertaking to drain storm waters by means of a canal constructed beyond its boundaries, pursuant to chapter 92, Laws of 1911, (Rev. Stat. 13-1055), has no authority to agree with an owner whose land is divided by the canal to maintain a bridge over the canal as partial compensation for the appropriation.

NEBRASKA METROPOLITAN CITY WHEN AUTHORIZED MAY ISSUE BONDS TO PAY FOR PARKWAY

The Nebraska Supreme Court holds, *Rasp v. City of Omaha*, 203 N. W. 588, that Nebraska Comp. Stat. 1922, §5610, confers power upon metropolitan cities to issue bonds to secure funds with which to pay for lands condemned for parkways, when duly authorized by a vote of the electors. Under that section, a majority of votes cast on the proposition is sufficient to carry the bonds.

NOTICE TO SURETY OF CLAIM AGAINST CON- TRACTOR

The Minnesota Supreme Court holds, *James B. Clow & Sons v. A. W. Scott Co.*, 203 N. W. 410, that an itemized and verified statement of the account of a subcontractor, indicating the job out of which the charges arose and stating the date of the last item, is sufficient notice to the surety of a claim against the general contractor, under Minn. Gen. Stat. 1923, §9705, requiring notice of claim before bringing action on surety bond.

DITCH PREVENTING EROSION TO HIGHWAY IS NOT A DRAINAGE PROJECT

The Minnesota Supreme Court holds, *Town of Vivian v. Town of Dunbar*, 203 U. N. 431, that a proposed ditch which is only to protect a highway from erosion, and not to afford drainage, is not a "drainage project" within the drainage statute and cannot be developed and advanced as such.